ENGINEERING NEWS

Tribune Building, New York City.

GEO. H. FROST, PROPRIETOR.

SATURDAY, AUG. 27, 1881.

WE learn from *Engineering* that the Belgian Contractors' Congress, originated and organized by the Chambre Syndicate des Entrepreneurs de Liége, opened on the 24th ult., and that the representation from foreign countries was small. The programme for discussion was so exhaustive in regard to pertinent subjects specially relating to the business of those present that only a portion of it was touched. The question which received the greatest amount of attention was that concerning the advantages and disadvantages of contracting at a fixed price for the whole work, or on a specified scale of charges. Although no absolute conclusion was arrived at, it is evident that the general feeling was in favor of tendering a lump sum. Another point discussed was the form in which security should be given by the contractor for the fulfilment of his undertaking. It is usual on the European Continent to make a cash deposit, and in addition a certain proportion—sometimes as much as 10 per cent.—is reserved from each payment, as additional security, until the completion of the work. The congress concluded that personal security should be entirely abandoned, and that a deposit of 5 per cent. on the total amount of the contract should be made in cash, bonds, approved securities, etc., and 5 per cent. of each payment retained. Among other matters of general interest to contractors were the various legal points connected with their work, their responsibility to their employers, to workmen and to sub-contractors, and the question of arbitration. It was proposed, in connection with the last mentioned point, to organize committees in various places, composed of engineers, architects, government officials, contractors and workmen, who should—as far as possible—settle disputes without recourse to law. The technical questions in regard to the employment of various materials, tools, etc., were not gone into. An exhibition was held at the Longdoz Railway station in connection with the Congress. The greater number of exhibits were of Belgium make, and included wood-working machinery, zinc roofing, building materials of all descriptions, contractor's plant, etc.

PERSONAL.

Mr. Thomas McKeown has been appointed Superintendent and Chief Engineer of the Detroit Mackinac & Marquette Railroad.

Mr. A. W. Gloster has been appointed Chief Engineer of the Pensacola & Atlantic Railroad, and all reports and requisitions in his department will be made to him.

Mr. E. C. Case has been appointed Chief Engineer and Superintendent of the Green Bay, Winona & St. Paul road, and will take charge of all the company's lines. Mr. Case has been for some years General Manager and Superintendent of the Sussex Railroad, which was recently sold. That company desired Mr. Case to remain as superintendent, but he prefered to accept the position above named. President John I. Blair, of the Sussex road, in a letter to Mr. Case, stating that the company desired to retain him, says that he wishes "on behalf of the company to express the great regard they hold for him as general manager and superintendent."

President J. W. Paramore issued the following order August 6: "R. L. Cobb, Esq., of Little Rock, Ark., is hereby appointed Chief Engineer of the Missouri & Arkansas Division of the Texas & St. Louis Railway Company, extending from Bird's Point, opposite Cairo, to Red River, in Arkansas. All engineers now in the field in that division will immediately report to him and obey his orders and instructions accordingly. Major C. F. Stephens, Chief Engineer of the Texas Division, will have charge of the extensions from Waco to Laredo and from Mt. Pleasant to Dallas and also from Texarkana to Red River, including the bridge across Red River. All engineers in that department will report to him at headquarters at Waco, Tex., and obey his orders and instructions accordingly."

THE WATER POWER OF NIAGARA FALLS.

F. R. Delano, cashier of the Cataract Bank of Niagara Falls, and clerk of the Bankers' Convention lately held at Niagara Falls, read a paper on the economic aspects of the various methods proposed and adopted for utilizing the water power of Niagara.

The following is an abstract of the author's remarks: The power of the steam engine as developed by Watt and Fulton threatened, for a time to prove that the power of water was of little value except as it was converted into steam for driving the new motors.

But this illusion, in the end, was dispelled by the peculiar necessities of the people of the United States and the peculiar condition of their new and undeveloped country.

It came to pass that the United States became the paradise of water powers, and the simple turbine of Fourneyon, that utilized 40 or 50 per cent. of the water used, grew into the more perfect designs of Swain, Boyden and others, which utilized from 80 to 85 per cent. of it.

Hence it is that we are soon to see a development of this peculiar power at Niagara which will stand unrivaled among motors of its class in the world.

There will be 3 turbines 4 ft. in diameter, with 80 ft. of head, fed by a tube 7 ft. in diameter; each turbine giving 1,000 horse power, with the whole power of the great lakes and the Niagara River to reinforce them.

If anything should produce catastrophism here, we might expect to have a stunning demonstration of the effect produced when an irresistable force strikes an immovable body. The experiment of using so great a head in turbines of such unusual dimensions will be watched by mechanical engineers with great interest.

As may be inferred from what has already been said, the extraordinary development of water-power for economic purposes is an American idea. In no other country has it been so extensively and so successfully utilized.

This will be apparent by taking into consideration some of our rivers which have been dammed for the benefit of mankind, and the force which they furnish reduced to the standard of horse-power.

The Passaic, at Paterson, N. J., 1,000 horse-power.

The Merrimack, at Lowell, Mass., 10,000 horse-power.

The Mohawk, at Cohoes, N., Y. 14,000 horse-power.

The Connecticut, Hadley, Mass., 17,000 horse-power.

The Androscoggin, at Lewiston, Maine, 11,000 horse-power.

The Housatonic, at Canaan Falls, Ct., 3,000 horse-power.

The Mississippi, at St. Anthony Falls, Minn., 15,000 horse-power.

The Oswego, at Oswego, N. Y., 4,000 horse-power.

The sum total of these approximates 75,000 horse-power as estimated at a given point on each river.

But this is used over again on an average of not less than three times. This would show a larger total of 225,000 horse-power. There are also very many smaller streams in all the hill sections of the country which are utilized, and may furnish used and unused equal to the last named total of 225,000 horse-power, thus giving a grand total of nearly 500,000 horse-power distributed over a wide extent of our country, and supplying in their ways the wants of 50,000,000 people.

But these are only the minor powers, so to speak, of the hills and valleys. The grand dominating power that could absorb them all and still have room to give hospitable refuge to four times many remains to be noticed.

It is the Niagara River.

From data furnished by the U. S. Lake Surveying Bureau in 1875, it appears that the average flow of the river above the falls is 10,000,000 cubic feet per minute.

Converting this into horse-power under a head of 200 feet, we have a grand aggregate of 3,000,000 horse-power, a force by the way which would supply the economic wants of 200,000,000 people.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 313).

LXXVI.—PEEKSKILL.

Peekskill, New York, is on the east bank of the Hudson River, 43 miles above New York City, on very irregular and steep hillsides. The town was incorporated in 1816.

In 1875 water-works were built by the city after the plans and under the superintendence of Chas. E. Fowler, C. E.

Water is taken from Van Cortlandt Creek and pumped by water power to a distributing reservoir. The water shed of the creek is about 5 square miles, the rock formation being mostly of gneiss, with some slate, overlying limestone.

A water power is obtained by damming Van Cortlandt Creek. A dam of pine and oak logs, faced with plank and backed with earth, and built in 1854, is 100 ft. long and 12 ft. high, founded on rock. Water is conveyed to the wheels and pumps through a timber and plank flume 114 ft. long, leading into an open canal, and thence into a forebay of timber and plank 47 ft. long. A pipe of wrought iron, 5 ft. in diameter and 16 ft. long, connects the forebay with the wheel-flume, which is laid over the wheel-pipe on 4 cast-iron girders. It is of wrought and cast iron, 16 ft. long, 7 ft. wide and 7 ft. high, with a semi-circular top.

The wheel-pit is 23 ft. long and 8 ft. wide, and the walls are of stone masonry. The foundations for the pumps start from the side walls of the pit and are carried over in an arch of stone masonry. The wheel-pit is excavated 3 ft. below lowest water line.

There are two pumps, similar in all their parts. They are placed horizontally and have plungers of 11⅛-in. diameter and 16-in. stroke. The pistons are connected to the opposite ends of the same shaft, at right angles. The shaft is geared to the wheel-shaft.

The wheels are "American" turbines, one of 36 and the other of 48-in. diameter, working under a head of 15 ft. and pumping against a head of 253 ft. through a rising main 8,738 ft. long and 12 in. in diameter. Their capacity is one gallon into the reservoir for 34 gallons expended by the wheel.

The distributing reservoir is formed in a basin

* Copyright 1881.

which had two outlets and gently sloping sides. It was excavated 6 ft. below the original surface, and the excavation carried horizontally until a depth of 9½ ft. vertically was reached except at the two outlets. The area thus excavated is about five acres. The material excavated was a mixture of yellow clay and loam, very wet, and was used in the dam and embankments. Under the constant tread of the horses and carts the bank became a mass of puddle. The material not used in the dam was deposited around the sides, raising them to a height 16½ ft. above the bottom. The surface of this side embankment sloped downward 1 ft. in 45 until the natural surface was reached. The two main dams are at right angles to each other, and are connected by an embankment with a curve of 150 ft. radius. The greatest height of this embankment is 13 ft., and its width on top 45 ft. It has inside slopes of 1½ to 1. A puddle trench was excavated along its entire length. The tops of the main dams are 18 ft. above the bottom of the reservoir, and the depth of water is 16 ft. and the capacity 26,000,000 gallons. From the pump-house the main ascends in nearly a straight line to within 100 ft. of the reservoir, where it connects with the supply main. A standpipe, 17 ft. high, inclosed in a brick tower, is placed near the junction, its overflow being of the same elevation as the flow line of the reservoir. This allows of direct service during repairs.

At the foot of the inner slope of the embankment is a circular screen well of cast iron, which rises to the top of the water. A square wooden box 300 ft. long ends in a bell-shaped opening. This box ends at the well in a cast-iron pipe fitted with trunnions, working in the base of the well and allowing the entire length to be raised or lowered. The receiving end of the pipe is suspended from a wrought-iron float so as always to be 2½ ft. below the surface. As the water enters on the bottom of the reservoir this arrangement allows the sediment to settle before distribution.

Distribution is by cast-iron pipe, of which 10.53 miles are laid, 7 miles being of 4-in. diameter. There are 84 fire hydrants and 371 taps.

The daily consumption in 1880 was 180,000 gallons, and the population 6,893.

The cost of the works to January, 1881, was $136,300.

The operating expenses, revenue and consumption have been as follows:

Year	Expenses of maintenance.	Receipts from water rents.	Total gallons used.
1877	$1,681.61	$2,636.60	59,679,730
1878	2,517.17	2,888.95	69,004,290
1879	1,775.94	3,045.90	64,980,740
1880	1,826.16	3,361.49	65,869,905
Totals	$7,800.88	$11,960.94	

The works are managed by a board of five commissioners. The superintendent is C. R. Swain.

LXXVII.—ATLANTA.

Atlanta, Georgia is in lat. 33° 44′ N., long. 84° 25′ W, 1,100 ft. above the sea, on the ridge which divides the water-sheds of the Gulf of Mexico and the South Atlantic coast. Settled in 1845, and first called Marthasville, it was incorporated as a city, by its present name, in 1847.

In 1875 water-works were built by the city after plans of A. R. Ketchum, C. E., and under superintendence of John A. Grant, C. E.

The supply is taken from the head-waters of the South river, which has a water-shed of about 12 square miles. The surface contains numerous springs. The ground is sandy, overlying clay.

The water is impounded in a ravine by an earth dam 214 ft. long and 55 ft. high. It has a heart wall of puddle 20 ft. wide at the base, 6 ft. wide at the top and 59 ft. high. The upper slope is 2 to 1, and the lower 1 to 1. The area of the reservoir is 51.3 acres.

Water is pumped directly into the mains by a Holly engine, with four steam and four water cylinders.

The pumps are 7¼-in. diameter and 19-in. stroke, and the nominal capacity is 2,000,000 gallons in 24 hours. The actual elevation pumped against is 193 ft., the equivalent lift under the domestic pressure is 256 ft. In 1877 a Holly engine of 25-in. cylinder with 33-in. stroke, working two rotary pumps, was added. The pumps soon wore out, and in 1880 the city was dependent upon the first Holly set.

These were unable to supply the demand, so that in many parts of the city no water was to be had, while in others it would not rise above the first story.

A new set of Holly machinery is now in course of erection.

In December, 1877, the date of the last official information received, there were 12.4 miles of cast-iron pipe in use, with 193 hydrants and 614 taps, and the daily consumption was 1,122,400 gallons.

The cost of the works had been $344,000, and the cost of maintenance in 1877 was $14,001, and the revenue $10,217.55. The population in 1880 was 34,398. The works were built and are managed by a board of five commissioners elected by popular vote. T. F. Wynne was the superintendent to 1878.

LXXVIII.—BURLINGTON.

Burlington, Iowa, is on the Mississippi River, on the eastern line of the State, in lat. 40° 50′ N., lon. 91° W. The ground rises gradually from the river to an elevation of about 200 ft. on the bluff.

Water-works were built in 1877 by a private company, taking water from the river and pumping directly into the mains.

An inlet crib of pine timbers floored and planked on the sides is placed in the river 250 ft. from the shore, in 19 ft. of water. A 24-in. cast-iron pipe, 235 ft. long, conducts the water from the crib to a filter bed 120 ft. long and 20 ft. wide, with stone masonry walls. The bottom is an inverted arch of 18 in. versed sine, over which is laid a floor of 2 by 4-in. scantling, with half inch spaces, on which is laid 3.5 ft. of graded gravel and sand. The water is introduced at the bottom and rises through the sand and gravel and flows over into the pump-well which is a semi-circle of 6 ft. radius. This was originally designed to filter at the rate of 400,000 gallons per day, but when the river is low it will not filter more than 300,000 gallons. When the rate of consumption exceeds this amount, as it does during the summer, muddy water is drawn direct from the river.

The water is pumped by a 4-cylinder Holly engine, with steam cylinders of 19 in. and pumps of 10 in. diameter and 27 in. stroke, keeping a domestic pressure of 90 lbs., and a fire pressure of 110 lbs. for the low ground and 140 lbs. for the high ground.

In December, 1879, corncobs were used for fuel, with a reported saving of 50 per cent. over coal, which then cost $2.62 per ton.

The distribution is by cast-iron pipe, of which 17.41 miles were laid to Jan. 1, 1880. Two miles were of 4-in. diameter. There were also then in use 1.8 miles of wrought-iron pipe of ¾ to 1½-in. diameter. There were 199 fire hydrants, 561 taps, and 27 meters. Enameled wrought-iron pipe are used for service pipe.

The daily consumption in 1879, as estimated from the pump strokes, was 302,170. The population in 1880 was 19,450.

The total cost of construction and maintenance to Jan. 31, 1880, was $254,390.71, and the receipts, including $5,000 from the city, $9,075.80.

The works were built after the plans of Thomas N. Boutelle, C. E. Ira A. Holly is the superintendent.

LXXIX.—ALTOONA.

Altoona, Pennsylvania, is in the centre of the State, on the line of the Pennsylvania Railroad, 1,600 ft. above the sea. The city lies in a long valley, the longitudinal streets being nearly level, and the cross streets rising steeply.

It was incorporated as a city in 1868. In 1871, the population being 11,000, water-works were built by the city after the plans of Henry P. M. Birkinbine, C.E., F. E. Lytle, C.E., being the constructing engineer.

Water is taken from a small impounding reservoir on a stream near the Horseshoe Bend, 6 miles from the city and 278 ft. above the main street, and is conducted through a 12-in. cast-iron main to a reservoir 200 ft. square, in excavation and embankment, the slopes paved with brick, built on a hill south of the city and 150 ft. above the main street. The reservoir is 20 ft. deep, but cannot now be filled over 19 ft. on account of leaks.

A connection between the distribution and the supply main is made just before the latter enters the reservoir, enabling a portion of the city to be supplied in very dry seasons independently of the reservoir, which at such times is held full for use in case of fire, the supply to part of the city being nearly cut off. A new storage reservoir holding 75,000,000 gallons, formed by a dam 40 ft. high across the supplying stream, is now in course of construction. The distribution is by cast-iron pipe, of which 16 miles are in use, with 98 fire hydrants and 1,400 taps. The daily consumption in 1880 was 500,000 gallons, and the population 19,740.

The works cost $300,000. The annual revenue is about $12,000, and the outstanding bonded indebtedness $200,000, bearing interest at 7/10 per cent.

The superintendent is John A. Baer.

The shops of the Pennsylvania Railroad have an independent supply of water, procured from an impounding reservoir recently constructed.

LXXX.—JOHNSTOWN.

Johnstown, New York, is in the northern part of the state, on Cayadutta Creek.

Water-works were built by the town in 1878, after the plans of P. H. Baermann, C. E., taking their supply from Cold Brook, which flows from the centre of a tract of sand hills, and which before the construction of the works was stated to yield 266,400 gallons per day; from Warren Brook, which has a water-shed of 0.25 sq. mile, and from an additional water-shed of 0.45 sq. mile. A timber dam across Cold Brook, 1,500 ft. from its first outcrop at the base of the sand hills, forms a storage reservoir of ½ acre area, and 12 ft. deep. An 8-in. cast-iron pipe, with fall of 33 ft. in 2,700 ft., then reduced to a 6-in. pipe with fall of 130 ft. in 700 ft., leads to the distributing reservoir, formed by an earth dam 250 ft. long and 25 ft. high, with a puddle wall in the centre, across a ravine. The capacity is 10,000,000 gallons, the water surface 2.5 acres and the elevation 282 ft. above the town at Cayadutta street, and 186 ft. above Montgomery street. From the upper end of the reservoir a 12-in. cast-iron pipe is laid 515 ft. on a level to a pond formed by a dam 5 ft. high across Warren Brook. This pipe serves as either a supply or waste pipe for the reservoir, according to the stage of water. From the reservoir the water is conveyed through 19,377 ft. of 10-in. cast-iron pipe to the village. The distribution is by 8-in., 6-in. and 4-in. cast-iron pipe, of which there were, on April 30, 1879, the date of the last report received, 4.6 miles laid, with 53 fire hydrants and 109 taps.

The construction cost $59,806.11. The receipts for the first year were $738.79. The bonded debt is $60,500. The population in 1880 was 16,626. The works were built and managed by a board of five commissioners. The superintendent in 1879 was James H. Pike.

LXXXI.—YONKERS.

Yonkers, New York, is on the east bank of the Hudson River, adjoining New York City. The Manor House, now occupied by the city offices, is in the centre of the business portion and is 17 miles from the New York City Hall. The building was

erected in 1752 on the Philipse Manor. The village grew up around it and the city was incorporated in 1872.

The Nepperhan or Saw Mill River empties into the Hudson about the middle of the town. A considerable fall in this stream affords a valuable water power, largely utilized for manufacturing purposes. South of this stream there is a plateau about 50 ft. above the river, a quarter of a mile wide, beyond which the ground rises quite steeply. North of the Nepperhan a bold promontory, between the upper portion of that stream and the Hudson, rises to an elevation of 150 to 350 ft.

In 1873 a small impounding reservoir was constructed, supplied by springs on the summit of the promontory, a mile south of the centre of the city, 3,200 ft. from the river and 297 ft. above it. This, now called Lake Avenue reservoir, covers three-fourths of an acre and holds 2 million gallons. Pipes were laid to the business part of the city. This work was intended for fire protection, in advance of the construction of permanent works. Wm. H. Grant, C. E., was the chief engineer.

In 1874-6 permanent works were built after the plans and under the superintendence of William W. Wilson, C. E. Water is taken from the Sprain and Grassy Sprain brooks, northeast of the city. The valleys of both streams are underlaid by rock of a primitive formation which frequently crops out. The Sprain water shed has 2.75 sq. miles and the Grassy Sprain 2.12 sq. miles area. A small masonry dam across the Sprain diverts its ordinary flow into a canal 5 ft. wide at bottom, with slopes of $1\frac{1}{2}$ to 1, paved with dry stone. It is 4.5 ft. deep and 3,330 ft. long. As it nears the outlet into Grassy Sprain reservoir its descent is rapid, with several vertical falls, intended to promote aeration of the water. The Grassy Sprain reservoir is formed by an earth dam 400 ft. long and 26 ft. above the stream, founded on rock at one end and hard pan on the other, with a puddle wall through the centre protected by two rows of sheet piling 15 ft. apart driven from 10 to 30 ft. into gravel. A rubble masonry core 3 × 3 ft. is under the puddle on rock, a trench filled with puddle cut into hard pan, and a concrete bed of 2 to 4.5 ft. thickness between the sheet piling below the natural surface. Where quicksand was encountered, an additional run of sheet piling was driven 5 or 6 ft. into the gravel and its top enveloped in concrete. A line of 48-in. pipe is laid through the dam resting on piles and enveloped in masonry. There is a gate house at each end of it. A 25-ft. waste way is built on rock at the west end of the dam. The reservoir is 9,000 ft. long, has 104 acres area of an average depth of 12.5 ft. and holds 406,000,000 gallons, with its surface 113 ft. above tide level.

There has always been some leakage under or around the dam, appearing in the stream a short distance below.

In 1878 a filter of gravel was built under a bridge a short distance above the dam on a road embankment across the resorvoir, dividing the basin into two parts, the lower of six acres area. All water reaching the outlet passes through this filter or under the bank.

A 24-in. cast-iron pipe conducts the water from the lower gate house, 3,552 ft., to a pump well, whence it is forced by a compound beam engine with high-pressure cylinder of 20-in., low pressure of 35-in., pump barrel of 22-in. and plunger of 14-in. diameter, all of 60-in. stroke, built by William Wright. Its nominal capacity is 2,225,000 gallons per day, lifted 225 ft. through 4,000 ft. of 18-in. main. The force main ascends 4,000 ft. to the summit of Fort Field Hill, where there is a self-acting air valve, and then descends for 4,525 ft. to the beginning of the distribution system. The Lake avenue reservoir serves as an equalizer of pressure and a safety valve.

On February 22, 1880, the steam valve of the engine having become stuck for an instant steam at full pressure was admitted to the cylinders during several revolutions, and the pressure on the force main was so great as to blow out the air valve at the summit of the main.

A Worthington engine of 3.5 million gallons capacity has been erected in 1881.

Distribution is by cast-iron pipe. The first pipes laid were uncoated. Since 1874 they have been coated with Dr. Smith's preparation. When laid in the trench pipes are tested for leaks under the full head before the trench is filled. In 1879 a joint in an 18-in. main started, permitting a jet of water to escape under 85 lbs. pressure, causing the earth around the pipe to act as a sand blast, wearing a hole in the spigot end of the pipe in front of the jet. The iron thus worn away was $\frac{1}{16}$ in. thick.

There were in use on January 1, 1881, 23 miles of pipe, of which 2.77 miles were less than 6-in. diameter. There are 246 fire hydrants, 750 taps, and 402 meters.

The daily consumption in 1880 was 900,000 gallons, and the population 18,892.

Water is furnished to a part of the 24th Ward of New York City under a special contract. This supplies less than 15,000 gallons per day.

The total cost of construction to Jan. 1, 1881, was $669,299.66. The cost of maintenance and the revenue have been as follows:

	Expenses.	Receipts.
1876	$ 2,972.51	$ 1,371.91
1877	10,062.32	7,712.19
1878	9,261.78	8,725.02
1879	7,750.92	11,944.44
1880	9,462.78	15,995.21

The works are managed by a board of five commissioners. William W. Wilson, C. E., is the engineer and superintendent. Gen. George S. Greene was consulting engineer during construction.

(TO BE CONTINUED.)

NEW YORK AND BROOKLYN BRIDGE.

(*Continued from page* 335.)

"Nearly four days were consumed in getting over the first by the traveler and fastening it, while the last one was drawn over in less than nine hours and fastened in less than five hours more, thus showing the superiority of the last plan over the first, and the increased efficiency of the workmen through practice.

"The cradles, ten in number, are nearly finished.* These in the main span are nearly 48 ft. long, and so arranged that the strands of the main cables will be within easy reach of the men who are to regulate the wires. The four cables in the land spans are about 7 ft. shorter than the others, owing to the fact that each pair of cables will be 14 ft. closer together on the anchorages than they are on the towers. The cradles are made of oak, in the most substantial manner, combining lightness and great strength. They are 4 ft. in width. The center of the floor is made in part of iron rods, so as to admit of the free passage of the wind, and thus reduce oscillation.

"The foot-bridge, which is to extend from one anchorage to the other, over the tops of the towers, will be made of oak slats 3 × $1\frac{1}{2}$ in., laid directly on the cables, with 2-in. spaces between the slats for the free passage of the wind. The slats are held in place by longitudinal strips 3 × $1\frac{1}{2}$ in., to which they are fastened by round clinch nails. When the floor is laid these strips will lie directly over the cables, to which they will be secured by U-shaped stirrups, plate-washers and nuts. This floor is all put together in sections of 12 to 16 ft., and as soom as the storm cables are attached it will be laid.

"When all the cradles are in position, each half of a traveler will have 7 supports between the anchorages, namely: one on each of 5 cradles, and one on each tower. Those on the tower will be made of 3 wood-lined sheaves, placed a short distance apart, those on the cradles will be single sheaves. Numerous wooden rollers will be required for the guidance of the wire when running out; but the position of many of these can be determined only by actual trial, when running the wire."

* This report was dated Dec. 30, 1876.

SPECIFICATIONS FOR STEEL CABLE WIRE.

The following is a copy of the specifications for steel wire:

"1. Sealed proposals will be received by the Trustees of the New York and Brooklyn Bridge, up to the 1st day of December, 1876, for the manufacture and delivery in Brooklyn, N. Y., of 3,400 net tons, or 6,800,000 lbs., of Steel Cable Wire, for the East River Suspension Bridge.

"2. For the information of parties living abroad it may be stated that the East River Bridge will connect the two cities of New York and Brooklyn, which are separated from each other by an arm of the sea, called the East River. That the bridge has has one main span of 1,600 ft., and two side spans of 930 ft. each, besides approaches at each end making a total length of more than one mile. The main floor is suspended by 4 cables, each 15 in. in diameter, each cable composed of 6,300 parallel-laid wires, which are laid up in place; and it is for the manufacture of these cables that the steel wire, called for in these specifications, is required.

"3. The general character of the wire is as follows: It must be made of steel; it must be hardened and tempered; and, lastly, it must all be galvanized.

"4. The size of the wire shall be No. 8, full; Birmingham gauge. A length of 14 ft. must weigh exactly 1 lb. before it is galvanized, but the weight of the galvanized wire is taken in making up the 3,400 tons.

"5. Each wire must have a breaking strength of no less than 3,400 lbs. This corresponds, in wire weighing 14 ft. to the lb., to a rate of 160,000 lbs. per sq. in. of solid section. The elastic limit must be no less than $\frac{4}{5}$ of the breaking strength, or 1,600 lbs. Within this limit of elasticity, it must stretch to a uniform rate corresponding to a modulus of elasticity of not less than 27,000,000 nor exceeding 29,000,000. The quality of the wire in regard to its stretching is further alluded to under the head of 'Tests.'

QUALITY OF WIRE.*

"6. The rods of which the wire is made must be of a superior quality of steel, suitable for wire purposes. It is not implied that the highest-priced steel shall be used, such as is required for fine cutlery, springs or the like, but it is only a superior steel rod which will make a wire that comes up to the standard here laid down.

In case the billets or rods are not made by the contractor for the wire it is to be understood that the inspector, on the part of the trustees, is to have ample facility to satisfy himself, by ocular proof, that they are actually made out of suitable steel and from uniform stock.

HARDENING AND TEMPERING.

"7. The standard called for in these specifications demands that this steel wire shall be of a uniform, medium quality: that is, it must be neither too hard or high in its character, nor too

*Note.—"It may not be amiss here to present a few of the reasons which led to the selection of the size and quality of steel wire adopted in the specifications. In all previous bridge cables, charcoal iron wire of either No. 10 or No. 9 gauge was used. In iron wire it is well known that a remarkable increase in strength is developed by the process of cold drawing. Thus a bar 1 in. square, having a strength of 40,000 or 50,000 lbs. to the square inch, will show a rate of from 90,000 to 100,000 lbs. per square inch of section, when drawn down to No. 9 or No. 10 size. In steel, this is also true to a moderate extent, while the process of tempering and hardening still further increases the strength. The use of this size has three advantages. The first is, that fewer wires are required to make up the cable, thus reducing labor. The second is, that its greater weight offers greater resistance to the wind—a most important consideration when laying a cable in a locality as exposed as the present one. The third, that it offers less comparative surface to rust. The use of a size much coarser than No. 8 is, however, barred by the extreme stiffness of the material, making it very troublesome to handle. In the question of strength, as regards the choice between using iron and the various grades of steel for cables, we find that the great length of the main span at once excludes the use of iron or the lower grades of steel. Even with the quality called for in these specifications, one-third of the strength is taken up in supporting its own weight; hence the use of iron wire bearing only 50,000 lbs. per square inch, or if the lower grades of steel is not admissible, because it would necessitate a cable of such weight and size that it would become unmanageable, and involve the greatest difficulties in making it. I at least, would not be willing to undertake it. The rate of strength decid d upon, namely, 160,000 lbs. to the square inch, represents a fair mean of all the objects that it is desirable to attain. It is true that steel wire of a very much higher rate of strength can be made. Its use would produce a cable much smaller than 15 in. in diameter. Now it is just as desirable to have too small a cable as too large a one. A certain bulk of cable is absolutely necessary in order to give a mass, and the inertia to resist dangerous oscillations in the cable itself. I would, furthermore, state that the dimensions of the anchor chains, the sizes of the saddles and plates, the weight of the anchorages and the shapes of the towers, have all been proportioned for a cable 15 in. in diameter, and made of steel wire of the strength above given. W. A. R."

soft or low in its temper. In order to insure this uniform quality it is necessary that all the cable wire shall undergo the operation of hardening and tempering. The particular manner in which this operation shall be performed is not prescribed here, but is left free to the manufacturer. There are at least four methods known to the engineer, all of which produce good results if properly adapted to this size of wire. Some of these processes are controlled by patents; others are of a secret nature. Whatever the process pursued by the manufacturer may be, the engineer or his inspector must have satisfactory evidence that every ring of wire has undergone this operation. At the same time the manufacturer must not lose sight of the fact that the wire is to be galvanized after being hardened and tempered. It is not intended, however, that this paragraph shall be an absolute bar to any other mode or process of manufacture of the steel and iron wire, provided the requirements in the foregoing paragraphs are strictly fulfilled; it being believed, at the same time, that only the operation of hardening and tempering will produce such wire.

GALVANIZING.

"8. The cables of the East River Bridge are suspended directly over a salt-water stream, and are, in addition, exposed to the salt air of the nighboring sea-shore. Experience has shown that the ordinary means of protection, such as paint, oil or varnish, which would be ample in the interior, are totally inadequate to prevent rusting in localities near the coast. The only certain safeguard is a coating of zinc, which acts by absolutele airtightness, as well as by its galvanic action, and is not easily abraded.

"The galvanizing must be done throughout in a thorough and perfect manner; each ring will be inspected in this regard by the inspector, when he tests the wire. All rings will be rejected which show spots imperfectly covered, or are full of rough lumps, showing a defective stripping. The galvanizing must be of uniform thickness, and must not scale off, or show any cracks when the wire is bent.

"The attention of the manufacturer is particularly called to the point that he must galvanize at such a temperature and in such a manner as not to destroy the temper of the wire. The manufacturer must run the whole risk in this respect, because the wire is inspected and tested after it has been galvanized. Samples which have been received and tested show that it is not difficult to reconcile these two operations, and that when proper caution is exercised, and the parties possess sufficient experience, the wire can be properly galvanized without impairing the temper.

STRAIGHT WIRE.

"9. All the wire called for in these specifications must be straight wire; that is to say, when a ring is unrolled upon the floor the wire behind must lie perfectly straight and neutral, without any tendency to spring back in the coiled form, as is usually the case. This straight condition must not be produced by the use of straightening machines of any kind, as they only injure the strength and elasticity of the wire. As the cables can only be laid up with straight wires, this necessity is obvious.

"To produce straight wire it is necessary to lead the wire from a point within the galvanizing trough in a straight line, under considerable tension to the guide sheave or winding drum, and to locate the sheave or drum at such a distance as to permit the wire to be cooled and set before it is coiled thereon. And also to make the sheave or drum of such size as will not cause a permanent bending of the cooled wire. Any method of cooling the wire more rapidly will permit of a less distance between the trough and drum. As the process above described has been patented, the trustees of the bridge have arranged with the patentee in reference to all the wire called for in these specifications, so that parties furnishing said wire will not be required to pay a royalty thereon.

MODE OF TESTING.

"10. Owing to the uncertain character of steel, and the percentage of rejection that usually attends the finished product, notwithstanding all the care and the amount of selection it may have undergone in the various stages of its manufacture, the engineer considers it absolutely necessary that every ring should undergo a test when finished.

"There will be four kinds of tests.

"*First.*—One ring in every forty will be tested as follows: A piece of wire, 60 ft. long, will be cut off from either end of the ring, and it will then be placed in a vertical testing machine. An initial strain of 400 lbs. is now applied, which should take out every crook and bend. A vernier gauge, capable of being read to $\frac{1}{1000}$ of 1 ft., is so attached as to indicate the stretch of 50 ft. of the wire. Successive increments of 400 lbs. strain are then applied, and the vernier read each time, until a strain of 1,600 lbs. is reached.

"The conditions now are as follows: That the amount of stretch for each of these increments shall be the same, and that the total stretch between the initial and terminal strains shall not be less than $\frac{1}{1000}$ of 1 ft., equal to $\frac{12}{1000}$ of the 50 ft. And furthermore, on reducing the strain to 1,200 lbs. there shall be a permanent elongation not exceeding $\frac{1}{1000}$ of its length.

"The same wire will then be subjected to a breaking strain, and the total amount of stretch noted. The minimum strength required is 3,400 lbs., equal to an ultimate strength of 164,000 lbs. per square inch. The minimum stretch, when broken, shall have been 2 per cent. in 50 ft. and the diameter of the wire at the point of fracture shall not exceed $\frac{15}{100}$ of 1 in.

"*Secondly.* One ring out of every five shall be tested by having a piece 6 ft. long cut off and placed in a testing machine with vernier gauge, so attached and graduated as to reach the stretch of 5 ft. of length to $\frac{1}{1000}$ of 1 ft. When strains shall be applied in the foregoing order, and the vernier read at each point respectively, if the results correspond with the requirements for the 50 ft. lengths, as regards modulus and limit of elasticity and ultimate strength, and the stretch of 5 ft. of length exceeds $3\frac{1}{2}$ per cent. of its length, the ring will be accepted; otherwise it will be rejected.

"*Thirdly.*—Every ring will be tested by having a piece 16 in. long cut from either end, and placed in a testing machine, having a vernier gauge, so arranged as to include 1 ft. in length of the wire, and shall be graduated as finely as practicable. Each piece will be subjected to the same strains mentioned for the 5-ft. lengths, and the results must correspond with the requirements before mentioned, excepting that of the ultimate stretch.

"These shorter pieces are used to expedite the testing, and to economize wire; but the requirements mentioned in connection with the 50-ft. tests will be insisted on, and any doubt as to results with the shorter pieces may be solved by testing a piece 50 ft. long. And in case one ring in forty should not be a sufficient test of the quality, then the inspector can select, at closer intervals, rings for 50-ft. tests. If want of uniformity is suspected a piece of 5 ft. in length may be taken from the other end of the ring.

"*Fourthly.*—Every ring will be subjected to a bending test by cutting off from each ring a piece of wire one foot long, and coiling it closely and continuously around a rod one half-inch in diameter, when, if it breaks, it will be rejected.

GENERAL REMARKS ON TESTING.

"At the first glance these tests may seem rather onerous and exacting in their requirements, but they will not appear so to a manufacturer who has been in the habit of having his work tested, and is desirous of not only maintaining, but adding to, an established reputation. The spirit of these tests does not consist so much in the rejection of a random ring here and there, as it does in impressing on the operatives, and all concerned, the assurance that no bad work can possibly pass the inspection. It is only when this has become a certainty that we can rely upon a steady and uniform character in the quality of the wire.

"Nothing is more common, for instance, than to lose the whole of the day's work by reason of a wrong temperature in the galvanizing bath, or to spoil tons upon tons by faulty tempering, all of which would be pushed for acceptance if there were no daily inspections going on. This is usually the case towards the end of a contract, when the final deliveries are wanted in a hurry. Finally, it may be said that in these tests no unattainable standard has been set up, but the requirements are such as can be filled with ease and certainty by many manufacturers.

INSPECTORS AND MACHINES.

"12. The inspection will be performed by the authorized assistants of the Engineer, or by specially appointed inspectors. They are paid by the Trustees. The testing machines, however, as well as all manual labor required in handling the wire, preparing the specimens, and the actual work of testing, must be furnished by the manufacturer. The testing machines will probably not be more than three in number, and this will be comparatively a small expense, as their capacity need not exceed two gross tons. After the system of inspection has once been thoroughly organized it will be found that the expense connected with it forms an exceedingly small percentage of the total cost of the wire. Proper room and facilities must be furnished for this work.

"In case of any dispute arising between the inspector and the manufacturer, the Engineer is to be the sole arbiter.

SIZE OF RINGS.

"13. Long rings are indispensable. The weight must average 60 lbs. None weighing less than 50 lbs. will be received, and they may be as much heavier as can be made, provided the ends are of uniform diameter. With the recent improvements in rolling machinery, long rings have become the rule instead of the exception, as was formerly the case. By having long rings the time and labor of splicing the wire is reduced proportionally. The splice being the weakest spot, we increase the average strength by having long rings, and by reducing their number. The wire is, besides, of so coarse a size, that even a 60-lb. ring will not much more than reach half-way across the main span. Hence, at the best, the relative number of splices will be far greater than in any previous cable. The rings must be of such a diameter as not to give the wire a permanent bend. The inspectors will also pay particular attention that both ends of these long rings have the same uniform gauge and thickness—as wire of uneven weight cannot be properly regulated in making the strands. This examination will be made before the wire is galvanized.

"Only one nipper mark can be permitted on the end of a ring, and that at a distance not exceeding 5 in. from the end.

"When the end of the wire is pulled through the draw plate for the purpose of fastening it to the block, it must be done at one operation, and not by successive applications of the nippers, as is usually done.

"The dents caused by the nipper jaws injure steel wire very materially, and hence *not more than one is allowed.*

GENERAL REMARKS AND TIME OF DELIVERY.

"14. It is required that the manufacturer will at once, upon the giving out of this contract, prepare to make and deliver about 50 tons of this wire. This is necessary, in order that the contractor can make the necessary preparations in the various processes of the manufacture, so as to be able to turn out the regular quantities in the time specified. In these preliminary 50 tons ample time is given to overcome all defects which may exist in the beginning, and also to come to a perfect understanding with the inspectors as regards any doubtful questions which may arise in regard to the modes of testing or the standards required.

"The regular deliveries of wire will commence Feb 1, 1877. The amount of these monthly deliveries must be no less than 150 tons, and in case it should be found that the cable making proceeds faster than at present anticipated, the manufacturer must increase this amount to 200 tons, upon being duly notified by the engineer, at least two months in advance.

"15. Inasmuch as the precise quantity of wire in these cables cannot be ascertained until some of the strands are actually made, and all the wire composing a strand has been weighed, the Engineer reserves the right to increase or diminish the quantity of wire called for in this contract by the amount of 200 tons, the same to be furnished at the regular contract price, provided he gives notice to that effect three months before the completion of the contract. * * *

"16. All parties who expect to bid on this wire are requested to send samples in accordance with these specifications, the samples to weigh not less than 100 pounds, and to contain two rings. Foreign parties may consign them to E. L. Alexander, 117 Liberty street, New York, marked Bridge Wire.

"17. The wire intended for shipment should be properly packed, and so wrapped as to avoid injury to the galvanizing.

MANNER OF BID.

"18. Bids will be received at so much per pound, gold, for the whole amount, delivered at the Brooklyn tower. It is deemed best to place the bids on a gold basis, in order to eliminate the question of the probable changes in the value of the currency for the period of time over which this contract will extend. It would be impossible to foresee these changes accurately, and the margin that the contractor would be forced to allow himself would, of necessity, be against the interests of the bridge. The duties on both the steel rod and on the finished wire are payable in gold. The duties on this kind of wire are at present $2\frac{1}{2}$ cents per lb., and 20 per cent. *ad valorem*. The cost of lighterage from the foreign steamship wharves on the North River, to the wharf at the Brooklyn tower, is about 65 cents per ton in currency.

Ocean freights, of course, differ according to shipping port.

No bid will be received which does not include the duties.

BONDS.

"19. In order to insure the complete and satisfactory performance of the requirements laid down in these specifications, the successful bidder shall give good and sufficient bonds to the amount of $50,000—gold. This will take the place of the back percentage which has usually been retained in other contracts.

PAYMENT.

"20. The Trustees will pay on the 10th of every month, in full, in gold, for all the wire delivered during the previous month.

"21. It is furthermore to be understood by the successful bidder, that if at any time during the performance of his contract he shall fail to comply with the terms of these specifications and produce a wire which does not come up to the test required, and has to be constantly rejected by the inspectors, or if he is manifestly unable to produce the necessary quantity in the required time, the Engineer of the Trustees shall duly and officially notify him, in writing, of this neglect and failure on his part, and if, notwithstanding this notice, the required improvement is not made, then the Trustees may declare his contract null and void, and shall have the right to contract with other parties at either the same price or some other price, and if loss should occur to the Trustees by this transaction, that they then have the right to take the whole or part of the aforementioned bonds of $50,000, to cover themselves from such loss.

"22. On the other hand, if from some unforseen circumstance, which at present the trustees have no knowledge of, they should be compelled to suspend operations on the work, they reserve the right to notify the contractor to suspend the delivery of the wire, either for a fixed or an indefinite period, provided they serve him with a notice to that effect, at least three months before such suspension; and the fact of having given such a notice is to be a bar against any claim for damages arising from the suspension of the contract.

(TO BE CONTINUED.)

LIVERPOOL'S WATER SUPPLY.

Liverpool is growing rapidly, the increase of the population and the extent of the town outstripping all estimates of twenty, or even ten, years ago. At present the town is supplied by what is called the Rivington Water-Works. The construction of these works occupied eight years, and cost £900,000 or $4,500,000. The scheme embraces seven reservoirs, which catch the water from 10,000 acres of moorland lying to the east of the towns of Bolton and Chorley. The highest of these reservoirs was not a part of the original scheme, but was forced upon the corporation by the Government to pacify the mill owners of the district, who dreaded injury from the intercepting of the upper waters. The act of Parliament stipulated that 13,000,000 per week should be sent down the original course of the Roddlesworth River, the waters of which had been impounded for the other reservoirs.

The reservoir has an area of thirty-eight acres, and holds 180,000,000 gallons. It was formed by constructing an embankment 374 yards long and 64 feet high across the valley of the stream. The corporation of Liverpool, however, before the works were completed, succeeded in buying the water. This reservoir, therefore, is at present used, like the others, to supply the town. Close to it is another, 16 acres in extent, 78 feet deep, and holding 100,000,000 gallons. Next to the two Roddlesworth reservoirs comes the Rake reservoir, of 14 acres, 78 feet deep, holding 80,000,000 gallons, and formed by an embankment 84 feet high and a mile long. This reservoir is provided with an overflow which allows all the surplus water of these three reservoirs to flow into the original stream. From the Rake reservoir a canal three miles and a half long and twenty-one feet wide at the bottom leads to the Anglezark reservoir, with an area of 192 acres, and a capacity of 1,079,000,000 gallons. An embankment 264 yards in length and 44 feet high, separates it from the Rivington reservoirs. These latter cover 275 acres, and contain 1,841,000,000 gallons, the depth being 40 feet, the embankment being 526 yards long and 60 feet high. To these was added the Yarrow reservoir of 73 acres, formed by by two embankments, one 737 yards long and 100 feet high, the other 181 yards long and 90 feet high. The total area of water in all these reservoirs is about 630 acres. It is filtered by being passed through several beds specially constructed for the purpose. The cost of filtering is estimated at $500 per annum per million gallons. In the city itself, are several service reservoirs, one of which is 6 acres in extent, and contains 17,000,000 gallons. It is arched over with brickwork, which is covered with turf, and is dedicated as a play ground for the public.

In 1865 the supply to the town from all sources was on an average 100,000,000 gallons a week, while 50,000,000 was given away as compensation. The demand, however, began to gain on the supply. Various projects were put forward to bring water from the English or Welsh lakes. Liverpool was anxious not to be outdone by her Scotch rival, Glasgow, which in 1859 had boldly tapped Loch Katrine, at an expense of $7,500,000, to obtain a daily supply of 21,000,000 gallons. After years of discussion it was resolved to construct a new aqueduct. The total length of this aqueduct, from its commencement six miles south of Bala Lake to Prescot, near Liverpool, will be 67 miles. The valley is about 780 feet above the sea level. At its narrowest part, where it is about three hundred yards across, an embankment 84 ft. high above the ground level will be erected. This work, by damming back the river, without any further artificial inclosure, will, with the natural sides of the valley, form a lake nearly five miles long, with a water area of 1,115 acres; that is, there will be created an artificial lake as large as Bala. The embankment will be of solid masonry, the excavations will be carried down to the solid rock at a depth of forty-one feet, the length of the tunnel from the river Marchnant will be a mile and a half, and that from the river Cowny a mile and a quarter in length. These tunnels are constructed with a view to the future, rather than the present. It is intended primarily to collect the water from the 17,583 acres which naturally drain into the Vyrnwy, but as the town increases in population the two streams will be diverted into the lake, giving an additional drainage area of 4,417 acres.

The Rivington water is somewhat discolored, especially after rain. This color arises from the moorland whence it is derived. The Vyrnwy water comes from a district of silurian soil, and is very pure. There is no district in Great Britain so thinly populated as this part of Wales. There are no mines or manufactures.

The aqueduct will commence by a tunnel 7 ft. in diameter and two and a half miles long, which will terminate in a cast-iron pipe of 42 in. internal diameter. Tunnels, where the ground permits, alternate with pipes, which are necessary where valleys have to be crossed. There will be only one raised aqueduct. Relieving tanks will be erected at intervals, and filtering beds constructed.

The estimated expenditure on the works in their complete form is $15,000,000, and it is anticipated that the first section of the works will be so far completed in 1885 as to allow the water to be delivered into Liverpool.

When the scheme is finished Liverpool will have an available supply of 52,000,000 gallons per day. The present consumption is 120,000,000 per week, so that there is a wide margin for future requirements. The present population of the town is 800,000. The resources of the Vyrnwy are ample for a population of 2,300,000. The total storage capacity of the lake is 11,900,000,000 gallons.

The Liverpool corporation has agreed to supply water to the towns of St. Helen's, Widnes, Warrington and Oswestry as soon as the Vyrnwy water reaches Liverpool.

From the time when the Rivington scheme was planned to the commencement of the Vyrnwy works Liverpool has doubled in population. Since the Croton works were determined on, in 1835, New York has increased from 270,000 to 1,206,000 inhabitants, or nearly fivefold, and the Commissioner of Public Works assures us that before any additional supply can possibly be furnished, the city will have outgrown the capacities of its present supply.—*New York Sun.*

THE ARLBERG TUNNEL.

The work of boring the Arlberg tunnel is proceeding very satisfactorily, and at a speed which affords a striking illustration of the improvements that have lately been effected in the art of mountain tunneling. The Mont Cenis tunnel was bored at the rate of 1,112 meters a year, the St. Gothard at the rate of 1,670 meters, and the Arlberg is expected to be pierced at the rate of 2,160 meters. The Arlberg engineers are also profiting by the experiences of their predecessors in the matter of cost, for while the outlay on the Mont Cenis tunnel was £400 per running meter and has been hitherto on the St. Gothard £250, the expense of making the Arlberg will not exceed £150 the meter. In this regard, however, the tunnel last named benefits by its shortness, since the longer the tunnel, other things being equal, the greater is its relative cost. An interesting experiment is being made in the Arlberg tunnel with a new sort of perforator. As is well known, the perforators used in the Mont Cenis and St. Gothard tunnels consisted of a series of chisels (not diamond-pointed, as has sometimes been stated) driven with a quick, hammer-like action by compressed air, the machines for the production of which were actuated by turbines at the two ends of the galleries. This system is the one in use on the eastern or Austrian side of the Arlberg. The chisels cover a space of 7 square meters, and make 20 to 25 holes at one time, each from 1½ to 2 meters deep. These are then filled with dynamite and the mine exploded. Every blast lengthens the drift by about 1½ meters. The perforators move forward on wheels, and the air, compressed to a pressure of five atmospheres, is supplied through flexible tubes. On the west side drills are employed of a diameter of 70 millimeters, to which by means of a water pressure of from 60 to 100 atmospheres a rotary movement is communicated. Six or eight of these drills are as effective as twenty or twenty-five of the atmospheric perforator, and the holes they make are so much wider that equal results are produced with lighter charges of dynamite. But the greatest difficulty in Alpine tunneling consists less in quarrying out a passage than getting rid of rubbish. After every blast, the outcome of it, in the shape of loose material, must be removed before boring operations can be resumed; and when an atmosphere already close and impure is still further fouled by the smoke of an explosion the labor of removal becomes dangerous as well as difficult. Fatal accidents sometimes happen. The leading miners in the Arlberg tunnel, when engaged in this work, cover their mouths and nostrils with sponges which have been steeped in vinegar, an expedient which has been found singularly efficacious in neutralizing the bad effects of the poisonous air they are often compelled to breathe. The important part which the removal of rubbish plays in these undertakings is shown in the fact that of the five years required for the making of the Arlberg tunnel, two and a half will be occupied in actual boring and excavating, and two and a half in carrying away loose material. Since June, 1880, when the work first began, the gallery on the east side has been driven 1,010 meters, that on the west 710.—*London Times.*

UNDERGROUND RAILWAYS IN NAPLES.

Last week a project for a *Ferrovia Metropolitana* was presented to the municipality. It has long been talked of, but until now has not been put forward publicly. Whether it will be encouraged remains to be seen. But it is stated that the Giunta will consider its details in one of its early meetings. The projectors ask only for the concession, without requiring the municipality to contribute to the expenses, and there can be no greater proof than this that the enterprise, in the opinion of the projectors, will be amply remunerative. The proposed railway will be constructed through the greater part of its course underneath the city, and as much as possible on the plan of the London Metropolitan. It would be useless to describe the direction of the railway to those at a distance unacquainted with the localities. Suffice it to say that, starting from outside the Grotta of Posileppo, it will pass through a tunnel to Mergellina, continuing its course underneath the high hill called the Vornero, which lies at the back of the city, under the Strada di Chiaja and various other streets, until it emerges on the sea, when it will double back and traverse other distant parts of Naples. That Italian engineers are equal to the construction of what will be a difficult line and a novel experiment we have abundant guarantees from Mont Cenis to Reggio, and the municipality will regard the project complacently, as it is not called upon to spend a farthing. How the capital is to be raised is another question, but every precaution will no doubt be taken. The great question after all is *cui bono*, and this can be answered most successfully. With its large population of 500,000 souls, locomotion in Naples is at all times difficult, sometimes even dangerous. There are, indeed, some spots where the danger of passing is as great as in any part of London. Add to this that the Neapolitans are a self-indulgent people, and will never walk when they can drive, so that with *carrozzelli*, omnibuses, private carriages and trams, which now run through the principal streets, there is not unfrequently a complete block.

Many of these inconveniences would be relieved by an underground railway, while several populous villages on the outskirts would be brought into speedy contact with the center. Some persons may be apprehensive of the effects of shocks of earthquake from our neighbor Vesuvius, but during the course of many years I can call to mind only one mishap which befell the Castellamare line, when Torre del Greco was destroyed by the upheaving of the great mountain.—*London Times.*

GERMAN RAILWAYS.

One of the most important of recent contributions to the literature of the "Railway Problem" is embodied in the official correspondence of the State Department for 1880, being a sketch of the railway history of Germany made by Dr. R. T. Ely, a fellow of Columbia College, at the request of Mr. Andrew D. White, our late Minister at Berlin, and by the latter transmitted to our government. Dr. Ely, it appears, had spent some three years in studying this and similar questions in Germany. His observations and conclusions are given in the space of fourteen pages of the volume of diplomatic correspondence. Every point relating to the political, military and economic bearings of the Prussian railways is elucidated in this painstaking and admirable dissertation.

Railway building commenced in Germany in (the year 1835. In 1838 the Prussian monarchy, which was not then allowed to contract debts unless with the consent of the "estates of the realm," which could not readily be obtained, and without which it was impossible to raise money for constructing state railways) passed what may be called a "general railroad law," which is still in force, fixing the conditions upon which such undertakings might be confided to private enterprise. Some of these conditions might have been adopted with advantage in this country. For instance, all shares subscribed for must be paid in full in cash and the money applied to the work before any borrowing can be done. No loan for construction purposes can be effected without the consent of the government, which has a right to require a sinking fund to be established for the liquidation of the debt. Railway tariffs must be conspicuously published, and no change which increases rates can go into effect until six weeks after publication, and no discrimination can be made between persons. When the profits of a railway exceed 10 per cent. upon the actual cost, the tariff must be reduced. (This provision, by the way, has always been evaded.) At the expiration of 30 years after the opening of any railway the state has the right of purchasing it at a maximum price equal to twenty-five times its average annual dividend during the five preceeding years.

Under this law rather more than one-half of the Prussian railways have been built. With the adoption of the constitution of 1850 the government acquired the means of constructing railways with its own resources, and it built several roads which were deemed too expensive or too little remunerative for private enterprise, the most important of which was one extending from Berlin northeastwardly to the Russian frontier. No definite railway policy was adopted by the state, and the two systems—that of private ownership and that of state control—grew side by side until the year 1866, when there were 3,600 kilometers in the former category and 3,300 in the latter. About one-half of the roads operated by the state were held under lease, the other half being owned by the government. By the political annexations of 1866 the government came into possession of all the railways owned by the annexed kingdoms and duchies. Nevertheless private enterprise outran the government, until the beginning of 1873, when private companies operated 7,000 kilometers against 5,750 operated by the state. In this year Dr. Lasker made his famous attack upon the Minister of Commerce, Count Itzenplitz, charging corruption in the administration of the general railroad law, whereby "concessions" or charters were granted to certain favorites of the Minister, and especially to Dr. Strousberg, and withheld from others. A protracted investigation was had which substantially sustained Dr. Lasker's charges, and led to Count Itzenplitz's resignation. The committee of investigation were charged among other things to inquire how far the intentions of the government in granting charters to private companies had been fulfilled. Under this head they reported that "railways are public highways resembling in essence and purpose other highways. The only means of justifying the government in relinquishing them to private industry and speculation is financial necessity. It appears desirable to transfer to the empire a controlling power over all German railways."

Nothing was done to carry this recommendation into effect until 1876, when Prince Bismarck brought in a bill in the Prussian Parliament to authorize the government, if it should desire to do so, to sell all the Prussian state railways, together with the government's right to acquire the private railways, to the empire. Inasmuch as the Prussian system is the preponderating railway force in Germany, its acquisition by the Imperial Government would give to the latter a great access of power as against the "Particularists," or State-rights party, who constitute the dominant faction in Bavaria, Würtemberg and Saxony. Prince Bismarck, in advocating the measure, made a speech, which would have delighted our Anti-Monopoly League.

The bill was passed by the Prussian Parliament. It remained for the empire to complete the bargain by purchasing the Prussian railways. The "Particularists" rallied against it in such force that it never was brought before the Reichstag at all. But Bismarck was not deterred by adverse public opinion; he seldom is. He redoubled the exertions of the government to gain possession of the private railways of the kingdom, in order to bring against the non-Prussian state railways the powerful competition which the united Prussian system, under a single control, is able to compass. By measures adopted in 1879, partly by purchase and partly by building new lines, the government became possessed of fifteen thousand kilometers (about ten thousand miles) of railway, or three-fourths of the entire mileage of the kingdom. It is now in a position to secure the remaining Prussian railways on its own terms, since it can destroy the value of their property by competition.

Prince Bismarck's railroad policy is bottomed upon political and military, rather than upon economic considerations. His leading idea in this, as in all his other large undertakings, is to consolidate the empire and extinguish the power of the separate states. He has no objection to the existence of courts and thrones at Dresden, Carlsruhe, Munich and Stuttgart, provided they confine themselves chiefly to parade and dumb show, and leave the essentials of government to Berlin. But railways are a source of real power, and so long as the local governments of Saxony, Bavaria, and Würtemberg own the lines within their borders they are of separate consequence in the councils of Europe. Bavaria, for instance, lying between France and Austria, holds a very important key of communication in Central Europe, and one which she is by no means disposed to surrender. Nevertheless, Bismarck's policy, in the opinion of Dr. Ely, will eventually prevail, and the Empire will come into possession of all the German railways it desires to own, though not perhaps in Bismarck's lifetime. The destiny of all French railways, by the terms of their charters, is to fall into the government's possession, without money and without price, at the expiration of ninety-nine years after their completion. This contingency operates as a powerful aid to Bismarck's plan for controlling the German railways, since it is deemed necessary to put the Empire on a footing of equality with her most dangerous neighbor.

While economic considerations are not of prime importance in bringing about this great change, they will be by far the most important when it is once affected. The advocates of state-ownership point to many advantages of the system which it is reasonable to suppose may be realized—namely, uniformity of tariffs, non-discrimination as between individuals and localities, the assurance that tariffs shall not be higher than necessary, and shall not be changed without good cause or without sufficient notice, the public satisfaction that must result from knowing that all surplus receipts go into the common treasury, etc. All these things may be realized in a country which has a civil service as rigid and business like and free from political interference as the New York Clearing-house, and without which the system of government ownership would be as much worse than that of private corporations as the Star-route system of mail transportation is inferior to that of Wells, Fargo & Co.—*The Nation.*

MEXICAN ITEMS.

"In old Mexico," says Gov. Hunt, "we have a little army at work, numbering 19,000 men. They are working from Mexico each way, and from Laredo also each way. I think our people are illy posted regarding the resources of Mexico. The mercantile world, especially of the States, seems to have very little conception of the resources of Mexico and what she has, so to speak, to swap away or exchange with us. They have almost every kind of tropical fruits, precious woods, cochineal, coffee, etc., and in turn they will want our manufactures, machinery, reapers, mowers, plows and various clas-es of agricultural and mining implements. Another thing: Throughout the republic of Mexico there are no navigable rivers, no good wagon road or means of transportation except on miserable carts, or on the backs of mules or Indians. These are the principal means of transportation. When they objected to the increased cost of transportation by rail I looked into the matter and showed them that they paid thirty cents per ton per mile for transportation by mule and man-back, while the railroad will carry it at the rate of three cents per mile. Having no navigable rivers, no good roads, why wouldn't they support railroads?"—*Indianapolis Journal.*

THE RAILROAD SYSTEM OF THE UNITED STATES.

The introduction to the forthcoming edition of Poor's "Manual of the Railroads of the United States" will contain some very interesting summaries of statistics relating to the railroad system of the country. The following table shows the gain of the year in mileage over 1879:

ROAD AND EQUIPMENT.

	1880.	Increase.	P. c.
Miles of road, total	93,671	7,174	8.3
Miles of road reporting	84,225 (Dec.)	490	0.6
Miles second tracks and sidings	21,978	1,937	9.7
Miles of steel track	33,680	.....	.....
Number of locomotives	17,949	865	5.1
Number of passenger cars	12,789	780	6.5
Number of baggage, mail and express cars	4,786	267	6.0
Number of freight cars	539,355	59,165	12.3

Curiously, though there had been an increase of 4,700 miles of road the previous year, which must have made a record as to capital, earnings, etc., in 1880, there was a slight decrease in the mileage reporting such statistics. The following statement in the introduction may explain: "During the year various consolidations were made in the Southern States, in consequence of which earnings to the amount of not less than $2,000,000 were not reported, in addition to a very large amount of earnings by companies whose officers refused information. The total earnings of all the railroads, 16,000 miles of the Southern States equaled probably $52,000,000." (The earnings of those reporting were $48,317,754).

It is probable that the reports of equipment cover most of the roads not reporting earnings. The addition to the stock of locomotives may seem small, but most new locomotives go to replace worn-out old ones, and 5 per cent. increase is likely to be sufficient to stock an increase of 8⅓ per cent. of road, most new roads requiring but a light equipment. The great increase in freight cars is what was to be expected, and is chiefly for old roads, several of which added each some thousands to their stock in the last year. Dividing by the total mileage for every 100 miles of road, there were:

	1880.	1879.
Locomotives	19.2	19.8
Passenger train cars	19.0	19.1
Freight cars	576.0	555.0
Accessory tracks	23.4	23.2

Showing an increase only in freight cars, which is what is to be expected when there is so large an increase of new road.

CAPITAL AND COST.

	1880.	Increase.	P. c.
Stock	$2,553,734,177	$73,768,232	3.0
Funded debt	2,392,017,820	109,477,755	4.8
Other debt	162,489,600	5,608,857	3.6
Total capital	$5,108,241,900	$188,854,844	3.8
Cost	4,653,609,297	237,098,450	5.4

The capital is given doubtless for the roads reporting earnings, etc., that is, for 84,225 miles in 1880, against 84,715 in 1879, and not including some of the roads reporting in 1879, whose place is made up with new roads. The increase, therefore, represents chiefly additions to the capital and cost of the old road. Per mile of road reporting the figures were in the two years:

	1880.	Increase.	P. c.
Stock	$30,320	$1,044	3.5
Funded debt	28,400	1,456	5.4
Other debt	1,920	78	4.1
Total capital	$60,650	$2,580	4.5
Cost	55,252	3,118	6.0

There thus was an increase of 4½ per cent. in stock and debts, and of 6 per cent. in cost per mile. If all the new road had been included, there doubtless would have been a decrease in all these items per mile. In view of the very great improvements

made on many roads during the year, the considerable increase in cost per mile was to be expected.

EARNINGS, EXPENSES AND PROFITS.

Gross earnings:	1880.	Increase.	P. c.
Freight, etc	$407,748,927	$81,072,820	21.0
Passenger	147,653,003	5,316,812	3.7
Total	$615,401,931	$86,389,632	16.3
Working expenses	360,208,495	51,112,920	16.5
Net earnings	$255,193,436	$35,276,712	16.0
Interest on bonds	107,806,328	*4,371,190	3.9
Dividends	77,115,411	15,433,941	25.0

* Decrease.

The very large increase in freight earnings is accompanied by a very moderate increase in passenger earnings, while from 1878 to 1879 there was an increase of 14 per cent. in passenger earnings and of less than 6 per cent. in freight earnings, the aggregate increase being 8 per cent. then against 16¼ from 1879 to 1880. The increase in working expenses was nearly in the same proportion, 16½ per cent., and there was left the very large increase of 16 per cent. in net earnings, amounting to more than $35,000,000. From 1878 to 1879 the increase in net earnings had been 17¼ per cent., amounting to $32,000,000.

Though the funded debt is reported to be $110,000,000 greater in 1880, the interest paid on it is reported as more than $4,000,000 less, and the interest payments amount to but 4.1 per cent. on the total amount of bonds, against 4.9 per cent. the year before. This is partly accounted for by the substitution of income bonds for other bonds in a number of reorganized companies.

The increase in dividends paid is 25 per cent., amounting to more than 15,000,000, and the gross amount is the greatest ever divided by the railroads of the country, though but little more than in 1875. The dividends paid were equal to 3.02 per cent. on all the stock outstanding, against 2.49 in 1879 and 2.34 in 1878.

The above items per mile of road reporting are, for three years:

Earnings:	1880.	1879.	1878.
From freight	$5,554	$4,504	$4,047
From passengers	1,752	1,680	1,585
Total	$7,307	$6,344	$6,232
Expenses	4,277	3,670	3,847
Net earnings	$3,030	$2,610	$2,385
Interest	1,280	1,333	1,312
Dividends	916	732	682

The percentage of increase in 1880 over 1879 is very nearly that given with the totals above, there being very little change in the mileage reporting. The average net earnings of $3,030 per mile of road reported for 1880 was sufficient to pay 7 per cent. on a capital of $43,300 per mile of road, 8 per cent. on $38,000, 9 per cent. on $33,700, or 10 per cent. on $30,300, all of which are very much lower figures than the average cost per mile in any country in the world.

The capital, gross earnings, expenses and net earnings per mile of road, and percentage of net earnings on capital of the railroads of the United States, for ten successive years, have been:

Year.	Stock and debt.	Gross earnings.	Expenses.	Per cent. Expenses to Earnings.	Per cent. Earnings on capital.
1871	$59,728	$9,040	$5,863	64.8	5.32
1872	55,116	8,116	5,224	64.4	5.25
1873	57,136	7,947	5,172	65.1	4.86
1874	60,964	7,513	4,770	63.6	4.49
1875	61,533	7,010	4,425	63.1	4.20
1876	60,791	6,764	4,228	62.5	4.16
1877	61,650	6,382	4,075	63.8	3.74
1878	59,040	6,232	3,847	61.7	3.04
1879	58,070	6,244	3,670	58.8	4.49
1880	60,650	7,307	4,277	58.5	5.00

Capital per mile has varied but little since 1874, at the close of the railroad construction period. Gross earnings per mile we see decreased continuously from 1871 down to 1878, made very little gain from the lowest point in 1879, but in 1880 leaped up at once, becoming the largest for six years. Expenses made a similar leap, yet not so far but that net earnings per mile were the largest since 1871. So the percentage on the capital formed by the net earnings decreased continuously from 1871 to 1877, and since 1877 has increased, and most of all last year, when it became just 5 per cent., which is as good an average as most European countries exhibit; this has been exceeded only in 1871 and 1872.

Of the increase of gross earnings, $58,000,000 out of the total of $86,000,000, and of the increase of net earnings, $86,000,000 of $35,000,000 is credited to the Western and Southwestern States, which, however, leave about 55 per cent. of the total mileage reporting. The Middle States, however, with 17¾ per cent. of the total mileage, had $29,000,000 (30 per cent.) of the increase of gross and $13,500,000 (26 per cent.) of the increase of net earnings. There is, however, a gain in all sections, indicating general prosperity.

THE QUALITY OF STEAM.*

BY JOHN W. HILL, M. E.

Experience shows that steam always carries a certain percentage of water in suspension as it rises from the body of water of which it is formed. This percentage will vary as between different forms of boiler, and the same boiler operated under different conditions. The water so suspended in the steam is known as water entrained or as primage. The raising of the water in a boiler by induction, when a large steam pipe is suddenly opened, is entirely independent of the water entrained, and is not meant by any allusion to primage in this paper. I believe it is a fact observed in chemistry that anhydrous gases cannot be obtained by direct vaporization, and that a special drying process is necessary to saturate or remove the liquid always entrained in the gas upon its first formation. Saturated steam (that is, steam charged with such an amount of heat that any reduction thereof would produce condensation, and any increase thereof would produce super heat) is substantially a perfect gas, and is usually so considered in all formulæ upon its action in a steam engine.

Our best information upon the temperature (heat) of saturated steam at various pressures is from the experiments of Regnault, *Comptes Rendus*, 1847, with which all steam engineers are sufficiently familiar to avoid the description of his apparatus or the circumstances under which his experiments were made, at this time. It is proper to state, however, that the experiments of Regnault were to ascertain the relations of temperature, pressure and density of steam; and as a corollary to determine the specific heat of steam and water at various boiling points. The determination of the relation of density and pressure was never made by Regnault, the only recorded experiments upon which were by Messrs. Fairbairn & Tate several years later.

It is now well known that the steam engine is a heat engine, that the water which is vaporized to form steam is simply a vehicle in which we store up the heat of the fuel, and which parts with a portion of this heat in transit through the engine, partly by conversion of heat into work, partly by conduction and radiation through the walls of the cylinder, and partly by the cooling effect of the atmosphere on the piston rod. No steam is expended in operating an engine; for the same weight of water as vapor which enters the cylinder by the steam pipe also leaves the cylinder by the exhaust pipe. If we deliver 1,000 pounds of steam at a given temperature to an engine through the steam ports, we shall draw off through the exhaust ports precisely the same weight of steam at a lower temperature. But during the passage of this steam through the engine a certain reduction of temperature has occurred, and the efficiency of the engine is a function of the limits of temperature between which the steam enters and leaves the cylinder, as enunciated by the junior Carnot more than 50 years ago.

To illustrate the efficiency upon the heat basis let us suppose an engine condensing—consuming—16½ pounds of steam per hour, connected with a battery of boilers furnishing 10 pounds of steam per pound of coal from the temperature of the feed. Let the thermal value of the coal be taken at 15,000 units, and estimate 75 per cent. of this, or 11,250 units, as contained in the steam above the temperature of feed water. Then the efficiency of such an engine would be

$$100 \times \frac{11,250 \times 1.65 \times 772}{33,000 \times 60} = 13.82$$

per cent., or of every 100 horse-power resident in the heat expanded in working the engine less than 14 are utilized, the remaining 86 horse-power going out in the exhaust. It is well known that the best economy we have any record of has been obtained from pumping engines, and that a duty of 100,000,000 foot-pounds per 100 pounds of coal is seldom attained. Now our condensing engine working upon 16½ pounds of steam, or one and sixty-five hundredths pounds of coal per hour, represents a duty of

$$\frac{33,000 \times 60 \times 100}{1.65} = 119,988,000$$

nearly 120,000,000 foot-pounds. From which it appears that about 14 per cent. is about a maximum efficiency with our present knowledge of construction. The object of this paper is, however, not to discuss the economy of steam machinery, but to show the necessity for an exact knowledge of the thermal value of steam, in estimating the economy of engine and boiler performance.

To illustrate the effect of a lack of knowledge of the quality of steam furnished by boilers, let us suppose a temperature of feed of 212° F., an expenditure of coal of 1,000 pounds, a consumption of feed-water of 12,000 pounds, and a boiler pressure by gauge of 125 pounds. The apparent evaporation from the temperature of feed in this instance is twelve pounds of steam to one of coal. Without information to the contrary, and in accordance with the usual practice, we would accept this as the evaporation and pronounce the result as extremely satisfactory. Suppose, however, the temperature of the steam, instead of being at saturation (1221.53 units), contained as a mean per pound only 1135 units; then the actual evaporation, instead of being twelve to one, would be ten and eight-tenths to one, and this instance supposes an efficiency of furnace and boiler of nearly 75 per cent., and a thermal value of 15,000 units per pound of coal. In brief, supposes a quantity of coal and efficiency of furnace rarely obtained. None of the usual devices applied to steam boilers are capable of measuring the thermal value of steam, and recourse is had to special apparatus for this purpose. Two distinct forms of calorimeter have been used; one the continuous calorimeter, in which the condensation of a certain small percentage of the steam is maintained during the entire trial of a steam engine or boiler, and the other the intermittent calorimeter, with which at stated intervals known weights of steam are drawn from the boiler or steam pipe and condensed in known weights of water.

The continuous calorimeter consists usually of a coil of brass pipe or copper of ¼ to ½-in. diameter of bore, containing 30 to 50 lineal feet. This coil is placed within a tin can, through which the circulating water passes from below upward. The upper end of the worm is connected with the steam pipe or steam drum of the boiler, and the lower end terminates in a neck which delivers the condensed steam into a receptacle mounted upon a carefully-balanced scale, with which the condensation is weighed from time to time, and dumped. The circulating or condensing water is measured by tanks of known capacity, or through a Worthington meter, the error of which is known by test. Standing thermometers are located as follows: One in the injection pipe, by which the circulating water enters the apparatus; one in the overflow nozzle, by which the circulating water leaves the apparatus, and one in the neck of the worm from which the water of condensation flows. Should there be an indication from the calorimeter data of super heat in the steam, an additional thermometer should be inserted in the head of the worm or in the steam pipe leading to it, to measure the super heat independently and check the record of the calorimeter. Steam flows through the worm and is condensed, the heat being transferred through the walls of the coil to the circulating water. The temperature of the circulating water is elevated through a range represented by the difference of temperature of the inflow and outflow. The temperature of the condensation as it leaves the calorimeter is read from the thermometer in the neck of the worm. The temperature of the steam is the unknown quantity which we seek. To illustrate the action of the continuous calorimeter assume a weight of steam condensed of one hundred pounds, a weight of circulating water expended in condensing it of 2,000 pounds, a temperature of inflow of 50° F.; a temperature of outflow of 105° F., and a temperature of condensation of 60°; then temperature of steam, neglecting small effect of variation in the specific heat, is:

$$60 + \frac{2000 \times 55}{100} = 1160°\text{F.}$$

Assume the steam as it entered the calorimeter, at a pressure of 135 pounds by gauge or 150 pounds absolute, at which pressure the temperature of saturation is, according to Regnault, 1,223.1 5 F. Then difference of temperature is 63.18 units, indi-

* A paper read before the American Railway Master Mechanics' Association, at the Providence Convention, June, 1881.

cating that a portion of the water was entrained in the steam.

To estimate the percentage of primage we must bear in mind that the water in the boiler is first heated to a temperature of 362.56° F. (corresponding to a pressure by gauge of 135 pounds), before vaporization takes place; and that additional temperature of 860.2 units is necessary to vaporize the water so heated; and that the discrepancy in the thermal value of the steam applies to the temperature of vaporization, whence the water entrained as primage becomes

$$100 \times \frac{63.18}{860.2} = 7.35 \text{ per cent.}$$

The intermittent calorimeter consists of a water-tight vessel (preferably of wood to avoid transfer of heat to or from the contents thereof by conduction and radiation) mounted upon a sensitive scale, into which a known weight of water is drawn. A small steam pipe, usually ¾ inch diameter, closely connected with the main steam pipe or steam drum of the boiler, dips into the vessel on the scale, and is provided with a cock or open-way valve to regulate the delivery of steam into the weighed quantity of water. The temperatures are taken with a hand thermometer. As suggested, a known weight of water is first weighed into the tank on the scale, usually some convenient quantity to estimate from, as 100 or 200 pounds, of which the probable condensation in the small steam pipe usually forms a part. The amount of condensation which will collect in the steam pipe between observations will vary with the quality of steam, and must be blown out to clear the pipe before the weighed quantity of steam to be condensed is blown in. The weight of water and condensation blown out of the pipe having been justified, the temperature of the contents of the tank is carefully taken with a reliable thermometer, and 5 or 10 pounds of steam blown in and condensed. (The weight of steam condensed should be as large as consistent with a limited temperature of the contents of the tank on the scale, to obtain a high range of temperature; since errors of weight are less liable to occur than errors of temperature, and the greater the range of the mercury the smaller the effect of errors of observation.) The desired weight of steam having been condensed the flow through the pipe is promptly suppressed and a second temperature of the contents of the tank is taken. The first temperature from the second temperature represents the range of the contents of the tank. To illustrate the principle of the intermittent calorimeter let the following data be assumed:

Weight of condensing water	100 pounds
We ght of steam condensed	5 "
Initial temperature condensing water	60 F.
Final temperature condensing water	115 F.
Range	55 F.

and the temperature of steam is

$$115 + \frac{100 \times 55}{5} = 1228 \text{ F.}$$

Supposing steam, as before, at a pressure absolute of 150 pounds, the difference between the quality in the illustration and saturated steam is 4.82 units, corresponding to a superheat of

$$\frac{4.82}{.475} = 10.15 \text{ F.}$$

I have not detailed the construction and action of the two well-known forms of calorimeter with the expectation of adding any to your knowledge thereof, but to bring the processes fairly before you previous to calling your attention to some of the results of my experience with the instruments. I shall not attempt, in the short time which, by courtesy, you allot me, to detail all my experiments with the calorimeter, as these are many and would frequently be simple repetiton of results, but shall refer only to a few experiments to show the value of investigations of this class. The first results we will examine are from a series of four experiments upon boilers set with smoke-preventing furnaces for the Cincinnati Industrial Exposition for 1879.

The first case was a return tubular containing 963.64 superficial feet of heating surface, and worked at a capacity equivalent to 2.77 pounds of steam per foot of heating serface per hour, which gave a temperature of steam of 960.46 units, indicating, with a pressure by gauge of 88.75 pounds, a primage of 26.26 per cent. The apparent evaporation from the temperature of feed (70.02° F.) per pound of coal was 7.59, but the actual evaporation from same temperature was only 5.6 to one. The second case was a return flue boiler containing 519.45 superficial feet of heating surface, and worked at a capacity equivalent to 1.73 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 864.73 units, indicating with a pressure by gauge of 80.29 pounds, a primage of 29.13 per cent. The apparent evaporation per pound of coal from the temperature of feed (166 01 F.) was 5.84, but the actual evaporation from same temperature was 4.14 to one.

The third case was a battery of 2 return tubular boilers containing 880.16 superficial feet of heating surface, and worked at a capacity equivalent to 3.20 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 1,005.93 units, indicating, with a pressure by gauge of 76.18 pounds, a primage of 23.19 per cent. The apparent evaporation per pound of coal from the temperature of feed (169.11° F.) was 9.69, but the actual evaporation was 7.45 to one.

The fourth case was a direct tubular boiler containing 327.79 superficial feet of heating surface, and worked at a capacity equivalent to 2.96 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 1,441.35 units, indicating, with a pressure by gauge of 81.60 pounds, a super heat of 18.83 per cent. The apparent evaporation per pound of coal from the temperature of feed (74.55° F.) was 8.80, but the actual evaporation upon the basis of saturated steam was 10.66 to one. This boiler was set and worked simply for test purposes, and was furnished with superheating surface. The continuous calorimeter was used in these experiments. The next results to which I shall refer are the calorimeter tests for quality of steam during the trials of steam engines at the Millers' Exhibition, Cincinnati, 1880. In this instance the experiments were all made with the same boilers, operated under approximately the same conditions from day to day. The boilers, two return tubular, contained 137.24 superficial feet of heating surface, and were worked at the following capacities in pounds of steam per foot of heating surface per hour, for six different trials—2.53, 2.42, 2.32, 2.41, 2.42 and 2.63—with corresponding temperature of steam of 1,243.84 units, 1,211.3 units, 1,315.86 units, 1,255.74 units, 1,301.65 units, and 1,313.11 units. Of these temperatures only one, the second, indicates primage; all others exhibit a slight super heat. The primage at 92.54 pounds pressure by gauge in the second experiment was .46 per cent. The percentage of super heat at 92.50 pounds pressure by gauge in the first experiment was 2.3; in the third experiment, with steam pressure at 91.65 pounds by gauge, 8.3 per cent.; in the fourth experiment, with steam pressure at 91.48 pounds by gauge, 3.34 per cent.; in the fifth experiment, with steam pressure at 91.44 pounds by gauge, 7.09 per cent.; and in the sixth experiment, with steam pressure at 91.54 pounds by gauge, 8.06 per cent. The continuous calorimeter was used in these trials.

The former results were from four different boilers of different forms and dimensions, and operated at different steam pressures and rates of evaporation, with a range in the quality of steam from 19 per cent. of super heat to 29 per cent. of primage, while the last six results were all from the same boilers, operated at different times, under approximately the same steam pressure and rates of evaporation, with a range in the quality of steam from 8.3 per cent. of super heat to ½ per cent. of primage. From which it appears that with the same boiler or boilers, operating under similar conditions, an approximately uniform quality of steam should be had, and that the quality of steam in any one instance cannot be assured for another, unless the conditions are precisely alike.

The next results to which I shall refer are from three different trials upon the same boilers, operated with similar steam pressures, and at different rates of evaporation. The boilers, two in the battery, were of the return tubular variety, containing 932.02 superficial feet of heating surface. During the first trial, steam was made at the rate of 4.09 pounds per foot of heating surface per hour, with a resultant temperature of 1,153.09 units, indicating a primage at 92.59 pounds by gauge of 7.08 per cent.

During the second trial the boilers were worked at an evaporation equivalent to 2.86 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,199.04 units, indicating, with a pressure of 92.95 pounds by gauge, a primage of 1.92 per cent.

During the third trial the boilers were worked at a rate of evaporation equivalent to 2.90 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,174.17 units, indicating, at a gauge pressure of 92.36 pounds, a primage of 4.75 per cent. These experiments were made with an intermittent calorimeter. In all experiments exhibiting a small primage in the steam, as a super heat, the boilers were set to expose more or less of the steam room to contact with the hot gas.

The next results are from a series of three experiments with a small locomotive boiler, operated standing.

For the first trial the heating surface was 288.75 superficial feet, and ratio of heating to grate surface 25.90 to one. The boiler was worked at a capacity equivalent to 8.49 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,150.98 units, indicating at 105.5 pounds pressure, by gauge, a primage of 5 per cent. The apparent evaporation per pound of coal was 4.45, and the actual evaporation was 4.09 to one.

For the second and third trials the heating surface, by the introduction of a water bridge into the fire-box, was increased to 300.7 superficial feet, with a ratio of heating to grate surface of 41.67 to one. During the second trial the boiler was worked at a rate of evaporation equivalent to 9.39 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,181.76 units, indicating at 98.25 pounds pressure, by gauge, a primage of 4.33 per cent. The apparent evaporation in this case was 7.58 pounds, and the actual evaporation 7.25 pounds of steam to one of coal.

During the third trial the boiler was worked at a rate of evaporation equivalent to 9.77 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,259.29 units, indicating a super heat of 88.67° F., at a pressure, by gauge, of 100.7 pounds. The apparent evaporation was 6.41 pounds of steam per pound of coal, and the actual evaporation upon the basis of saturated steam was 6.65 to one. The rate of combustion and evaporation was higher for the third trial than for the second, with a better quality of steam and a reduced economy. In these trials the coal was burned within fixe or six per cent. of the total weights charged, and the calorimeter results can be fairly compared without correction.

The next result to which I will refer is from the boiler of a "Rogers" engine on the Ohio and Mississippi Railroad, in a running trial from Vincennes to Seymour, made last July. The heating surface was 984.33 superficial feet, and the rate of evaporation equivalent to 9.51 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,192.11 units, indicating a primage of 3.4 per cent., at a pressure, by gauge, of 125.56 pounds. The apparent evaporation in this instance was 3.97 pounds per pound of coal, and the actual evaporation was 3.83 to one. The poor economy of this boiler was largely due to the high rate of coal consumption (146.25 lbs. per superficial foot of grate per hour). With large grate areas and a reduced rate of combustion per superficial foot of grate per hour, the economy of locomotive boilers may be materially improved, as shown by the results obtained with the "Wooten" boiler on the Philadelphia and Reading Railroad.

I am aware that some of my professional friends are not seized of my faith in the reliability of calorimeter results; but I am unable to obtain from them any better objection than that some modifying data have been overlooked or neglected in those cases which do not meet their approbation. However, when they agree, as they invariably do, that condensed steam and condensing water may be accurately weighed, and that approximately accurate temperatures may be had with good makes of thermometers, then I can conceive no other objections to accepting the results of calorimeter experiments than the personal errors of observation which pervade all mechanical investigations. If the power of steam engines is to be measured by the indicator, or the less reliable dynamometer or friction brake; if the economy of boilers and engines is dependent upon the accuracy of weighing scales; if steam pressures are to be taken from spring gauges and temperatures read from mercurial thermometers, and such results are held to be reliable for absolute and comparative effect, then the same reliability must, in simple justice, be accredited the calorimeter, for it depends solely upon correct weights and temperatures, and involves no complex or uncertain quantities in the operation.

Liverpool is to be supplied with water from the mountains of Wales. The scheme is to create an artificial lake one mile wide and five miles long for a reservoir, then to tunnel a mountain two miles, and send the water to Liverpool, 67 miles.

FOREIGN INTELLIGENCE.

George M. Pullman has completed arrangements for operating a fast Pullman train on the London, Brighton & South Coast Railway, Eng. One car will have a restaurant and news agency. The company will experiment with the American system of checking baggage.

In the United Kingdom there have been opened, since George Stephenson began his labors, more than 17,000 miles of railroad, representing, at the rate of considerably more than £50,000 per mile, an aggregate value of £700,000,000, and conveying, exclusive of season ticket holders, the hardly conceivable number of 600,000,000 passengers.

The Baldwin Locomotive Works are now shipping for Brazil five passenger locomotives for the Dom Pedro Y Railroad, two freight engines for the Bahia road, one for the Santa Isabel and Rio Preto Railroad, and one for the E. de F. Pirapetinga road. The Baldwin concern is now doing a larger business than at any time since its establishment half a century ago, 2,000 hands being steadily employed. During the next eighteen months, by contracts already made, it will send to Mexico some 200 locomotives, worth in the neighborhood of a total of $2,000,000.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

Chicago consumes 70,000,000 gallons of water daily, yet bears the unenviable reputation of being the dirtiest city in America.

LONDON, Can., Aug. 17.—It was announced at the meeting of the Water Commissioners last night that the Hamilton contractor is building an engine of three million gallons capacity for the improved water-works here.

A by-law was carried on the 18th inst. in the town of Dundas, Ontario, by 183 majority for water-works, as a protection from fire; also for domestic purposes. The Company are to furnish water for the town at $2,500 a year.

WADSWORTH, O., Aug. 17.—Our people are very much amused over the matter of securing a supply of water for public and private purposes. A company is organizing to conduct several springs to town, and $2,850 was subscribed for that purpose since yesterday.

Mr. Loring, the Commissioner of Agriculture, has requested Prof. C. A. White, of Greeley, Col., and Prof. Samuel Aughey, of Lincoln, Neb., to act as a commission for the selection of a site for sinking experimental artesian wells in the arid plains east of the Rocky Mountains.

The City of Dover, Del., has contracted with the Holly Manufacturing Company, of Lockport, N. Y., for the construction of water-works on the Holly system. Owing to the great demand for cast-iron pipe and the difficulty in securing a sufficient quantity except at high prices, less than half the length of mains will be laid this season.

DUNDAS, Can., Aug. 18.—A by-law for water-works for fire, manufacturing and domestic purposes was carried here to-day by 183 majority. The works are to be constructed at once, and a reservoir of one million gallons capacity is to be placed at an elevation of 250 feet above the lowest level of the town. Mains are to be put down on all the principal streets, with an ample supply of hydrants.

Last week's Wadsworth (Ohio) *Enterprise* gives the details as to the proposed system of water-works for that village. A committee, of which P. C. Hard, Esq., is chairman, reports to the Council that a sufficient supply of fresh spring water can be obtained at a nominal charge on the farm of S. T. Franks, one mile northeast of the town; that a 3,000 barrel reservoir can be built for $500; that a pressure of 45 lbs. to the square inch can be obtained; that the expense of piping will be about $3,200; that it will cost the village about $100 per year for water for public purposes, and private consumers about $6 a year, and that other expenses connected with the works will not run the total up to exceed $4,000.

The Brooklyn Board of City Works, through its Chief Engineer, has declined to accept the pumping-engines recently erected by Contractor Seth L. Keeney at Springfield and Watts' ponds, at a cost of $70,000. Mr. Keeney is not directly responsible for the failure of each of the two engines to pump 3,500,000 gallons per day, as he sublet the contract for the construction of the engines. The engineer, Mr. Lorette, has promised to reconstruct the engines and give them a pumping capacity of 4,000,000 gallons each. Plans are now being prepared by the City Works Engineer for the construction of a new waste weir at Baisley's Pond, which will cost $3,000.

The Boston Common Council discussed the proposed taking of water from Lake Winnipiseogee in New Hampshire last week, but took no definite action. An order was passed appropriating $15,000 to carry out the order of the court in purifying the Mystic water supply. The annual water report was made. The average daily consumption of water was 35,887,880 gallons, an increase of 3.8 per cent. Sudbury River has supplied the city with 6,230,200,000 gallons; there were 856,840,000 gallons pumped at the Highland station, and the cost per 1,000,000 gallons raised one foot was 8.3 cents. The receipts of the Cochituate water-works for the year ending April 30, 1881, were $1,225,452; amount charged to the same works, $934,019; balance, $291,433; excess of income over all requirements, $12,870. The receipts of the Mystic water-works were $246,904; amount charged to the same works, $198,476; balance, $48,428; excess of requirements over income, $51,788. The unexpended balance on the Mystic sewer is $16,882.

In noting the advantages of a Newport connection over the Markley farm as a source of water supply for Cincinnati, it should be borne in mind that a reservoir on the highest point of the farm will not supply Eden Park reservoir without additional pumping apparatus at the Park, or some other convenient point, to lift the water to the level of the Eden reservoir. The height of the Newport reservoir—which may be considerably elevated, if desired—is now 56 feet above the Park reservoir, which is ample to carry the water from Newport to the Park without additional pressure. This is a point of no little importance, as the extra pumping apparatus for the Markley supply will cost heavily in the original purchase; besides being a constant source of trouble and expense. How would it do for Cincinnati, Covington and Newport to unite and make a great big reservoir, with pumping facilities capable of furnishing all three cities with a full supply of pure, clear water? Is not the idea capable of being accomplished with economy to all concerned.—*Cincinnati Commercial.*

RICHMOND, Va., Aug. 22.—Owing to the low condition of the water in the James River, resulting from a continued drought, this city is now suffering from the worst water famine it has ever known. For several days past the elevated portions of the city have had no water from the usual source of supply, and now the whole city is in the same condition, and it is only at intervals that any water can be had from the water-works. This scarcity has caused the suspension of almost all of the industries which rely on water-power for manufacturing purposes. All the residences are without water for even necessary purposes, except such a supply as can be had from a few old wells and springs which heretofore have been considered almost unfit for use, the water from them having been declared unhealthy time and again. A dispatch of the following day says: The water for the city supplied between 6 p. m. and midnight, from the old canal, now only used to supply water to the Tredegar Works, Gallego Flouring Mills and several other establishments, was cut to-night, by order of the Mayor, and the water turned into the dam in the James River from which the city water-works obtains its supply. This action makes necessary the suspension of these works, and great loss, as well as to throw thousands of workmen out of employment.

Mechanical Engineer Lowry, of Pittsburgh, Pa., has published a report of over two columns in length. This was in response to a recent resolution passed by the committee. The report includes the history of the water-works from their inception, showing the expenditures, trouble with contractors and other matters familiar to every Pittsburgher. The report concludes with the following recommendations: First—I would recommend that the new work be put into the best possible condition as soon as possible. Second—That water be furnished to all the manufacturing establishments at the lowest possible rate, and that in case any fail to take advantage of the low rates by the year, they shall be charged double for the supply that is furnished for any time less than a year. Third—That water meters of the most approved pattern be placed on all pipes connected with manufactories, hotels and public works. Fourth—That the city make each year a proper appropriation for the use of the water in the public buildings, schools, fire plugs, and street washing. Fifth—That the city police shall have authority to arrest or report all unnecessary waste of water, and shall receive from the water department compensation for their service. Sixth—That no service pipe shall be laid hereafter that will not pay the interest on the expenditure, both for pipes, water and labor.

ELECTRICITY.

Quite $12,000 a year is saved by lighting Philadelphia post-office by electricity.

The telegraph and telephone wires in Boston are to be buried in terra cotta two feet pipes.

A new telegraph line is about to be constructed along the Grand Junction Railway from Belleville to Peterborough.

A patent has recently been taken out for a means of steering a ship by electricity. The apparatus is the invention of Mr. W. F. King, an Edinburgh electrician, and was recently tried on board a steamer sailing between Glasgow and London. Its object is to dispense with a helmsman and make the compass itself steer the ship. For this purpose the compass card is fitted with an index which is set to the true course, and one degree on either side of the true course two metal contact pins are adjusted; each pin is connected to a single Daniel cell, and when the ship deviates as much as a degree from her course to one side or the other the index comes into contact with one or other metal pin. The result is that a positive or negative current flows and actuates a hydraulic apparatus which works the helm.—*London Engineering.*

A startling accident occurred at the station of the Brush Electric Light Company in Buffalo a few days ago. As usual in electric light offices, the generator, a powerfully compact machine, was placed in the most public part of the room, guarded only by a light railing of iron rods. The current from this particular machine, estimated to be equal to that of 225,000 ordinary battery cells, was gathered from the magnets by a brass and copper "accumulator," furnished with six copper strips or "brushes," three on each side. For the amusement of visitors, a slight shock is sometimes given to a number of persons, who join hands and complete the circuit from one of the brushes, and a stout, healthy man, who had perhaps seen this done, attempted to gratify his curiosity by leaning over the railing and touching the strips. He was stopped by the officials in charge of the station, but soon made another attempt and was ordered out of the office. This made him angry, and in a few minutes he returned, saying that he was going to stop the machine. The gentlemen in charge were busy in another part of the room, and taking advantage of their inattention, he leaned again over the railing and grasped two of the strips, one in each hand. In an instant he fell with a gasp upon the railing, and although the current was shut off immediately, he was dead before his hands could be unloosed from the strips. A post-mortem examination showed that the current had paralyzed the nerves of respiration, and death was almost instantaneous.—*The American Architect and Building News.*

STREETS, DRAINAGE, ETC.

Youngstown, O., is agitating the question regarding a system of sewerage; the majority of the citizens favor the movement.

Philadelphia streets are being cleaned by double gangs, and the mayor has signed the new street-cleaning ordinance, which is expected to make the reform permanent.

At a special meeting of the City Council of Columbus, O., on the 16th inst., the contracts for constructing the two large sewers known as the northeast and northwest sewers were relet, the original contractors having failed to carry out the provisions of their respective contracts.

BRIDGES.

The Richmond, Alleghany & Ohio Central Railroad has incorporated companies and secured State permission to build a bridge across the Ohio River at Pomeroy.

Plans for a bridge across the Mississippi River at Minneapolis, Minn., have been ordered by the Manitoba Railroad Company. The bridge will cross the river with a double curve just below the falls.

W. C. Irwin, Engineer of Bridges on the Cleveland, Columbus, Cincinnati & Indianapolis and St. Louis railroads, has now under contract $100,000 worth of iron bridges for his roads, to be erected and in running order by December 31, 1881, besides ten spans of Howe truss bridges the companies are building themselves.

Manchester, N. H., is now celebrating the completion of the largest and most expensive bridge in the State. The bridge spans the Merrimack, at the foot of Bridgeport. The style of the bridge which forms an extension of Bridge street west from Canal to Main, is the "Douglas patent parabolic truss," a style used in the largest truss bridges of Europe, and in two cases built to spans of 455 feet. The system was introduced into this country four years ago by the Corrugated Metal Company, and since that time it has been almost universally adopted in the Eastern States where new bridges have been built. It is a combination of two parabolic arcs, united at their ends, the two being trussed together by the ordinary system of vertical struts and inclined ties. The top chord is formed from two channel bars united on top by a continuous plate, and at the bottom by baton plates. The bottom chord consists of hydraulic forged eye-bars. The intermediate posts are channel, latticed, the whole being connected together in the ordinary manner of all first-class American bridges, by pin-connected joints. The system of details used, leaves every part of the structure easy of access where painting is required, a great improvement over some of the old systems of tubular chords and posts. The bridge is what is known as a double decker, having two roadways, one being 25 feet above the other. The upper roadway is 1,007 feet long and 40 feet wide, and the lower one 415 feet long and 18 feet wide. The upper canal bridge has a span of 53½ feet clear, and the lower canal 51½ feet. The upper floor of the main bridge is divided into two sidewalks, each 6 feet wide in the clear, with a strong, ornamental wrought-iron railing 3½ feet high on the outer edge. A timber wheel-guard, 8 inches high, separates the roadway from the sidewalks. The floor will be lighted by 14 handsome lamp posts and lanterns. In the construction of the bridge there have been used 44,096 pieces of iron, besides 116,465 rivets, the latter all being driven while hot. The bridge as it now stands cost $67,000, $7,000 of which has been contributed by the corporations. With the extension that will be made in the Fall, the cost will be increased to $75,000. The company which erected the bridge has made about 70 contracts this summer. The following facts in regard to the old McGregor bridge on this site are condensed from "Potter's History of Manchester:" The Amoskeag Bridge Company was incorporated at the session of the General Court in June, 1792, and shortly after the proprietors organized and actively commenced operations. On the third day of August they commenced cutting the growing timber, and on the twenty-ninth day of the following month the bridge was passable. For the time, the enterprise was a great one, and it was mainly through the energy of Robert McGregor, Esq., who lived just across the river in Goffstown, and for whom the bridge was named, that it was successfully completed. A Boston newspaper of October, 1792, thus speaks of the bridge: "AMOSKEAG BRIDGE.—In the State of New Hampshire, was begun on the 3d of August last, at which time the timber was growing, and the rocks dispersed in the river. On the 29th of September follow-

ing, which makes 57 days inclusively, the bridge was passable for travelers, and is now completed. Dimensions—556 ft. in length; is supported by five piers and an abutment on each side; the piers are 60 ft. in length and 80 in width, the outside made of hewn timber, and filled with stones." For some years this bridge was kept in repair, but it was gradually suffered to go to decay, and somewhere from 1812 to 1815 it became impassible for teams. In the month of November, 1824, a company was started to replace the old bridge. The stock was divided into one hundred shares, and the company was incorporated in December following. But eight shares of the old stock could be found, and these were purchased for eight dollars. It does not appear that any others were ever bought in. The contract for the bridge was let to Col. Wm. P. Riddle, for $3,600, and the structure was completed in November, 1825. It was twenty feet wide, had seven wooden piers, and a stone abutment on the east side of the river. In 1837 it was repaired at an expense of $1,500. The next spring the bridge was sold, the Amoskeag Company buying the stock of the proprietors. The old officers resigned, and on April 4 a new set were chosen, consisting of parties interested in the Amoskeag Company. Toll for foot passengers was then abolished. In the spring of 1848 a freshet took two piers from the west end of the bridge. The injury was repaired and the structure remained till 1851, when the high water carried it completely away forever.

RAILROADS.

Fifty-two railroad companies have been incorporated in West Virginia within the last nine years.

The Richmond & Danville Extension Company is to build ex-Senator Gordon's Georgia Pacific from Atlanta to the Mississippi.

The Monroe Branch of the Milwaukee & St. Paul Railroad is finished as far as Gratiot, Wis., and the work between that place and Shullsburg is progressing finely.

The Ontonagon & Brule River Railroad Company has purchased 1,800 tons of steel rails and all the material required to complete the first twenty miles of the road, have over 500 men at work and will complete it before the 1st of December.

Three gangs of tracklayers are at work on the New York, Chicago & St. Louis Railroad, completing three and a half miles per day. At least three hundred miles will be in operation by November, and the entire road will be finished in the spring.

Three gangs of tracklayers are at work on the New York, Chicago & St. Louis Railroad, completing three and a half miles per day. At least 300 miles will be in operation by November, and the entire road will be finished in the spring.

The Texas & New Orleans Railroad Company gives notice that it has acquired and will hereafter operate the Louisiana Western Railroad. This line of road extends from Vermillionville, La., to the Sabine River, in Texas, and is about 106 miles long.

A large force of men are at work on the road-bed of the Boston, Hoosac Tunnel & Western Railway. The company is pushing the work all along the line from Saratoga to the iron bridge which spans the Hudson at Centerville with great vigor, and expects to have cars running on the new branch before January.

The first spike of the Baltimore & Delta narrow-gauge was driven Tuesday afternoon under the North avenue bridge, Baltimore. The original survey for this road was made in 1853. Baltimoreans say it will yet be the connecting link between their city and the Delaware Western in a new through line to Philadelphia.

The Chicago & Northwestern standard-gauge road from Madison to Montfort, Wis., was completed to the latter place last Friday, and regular trains will be run from Galena, Ill., to Madison, via Montfort, as soon as the necessary side tracks are put in at that place, giving another outlet to Chicago and Milwaukee.

Work has commenced in earnest on the Chicago & Indianapolis Air Line south of Delphi. Some 500 men and teams are already employed, and the force is to be increased next week. The more enthusiastic friends of the road say that trains will be running between Delphi and Indianapolis before January 1, 1882. This is rather doubtful, however.

Work on the southern division of the Indianapolis and Evansville straight line is being pushed vigorously. Last week $115,000 was invested in securing an entrance and terminal facilities for the road at Evansville, purchasing "all that part of the main line of the Wabash and Erie Canal lying within the corporate limits (as they were on the 25th day of April, 1878) of the city of Evansville."

A Philadelphia street railway company proposes to adopt the wire-rope system of hauling street cars, now in use at San Francisco, and just introduced at Chicago. The wire-rope does away with horses entirely. It costs seventeen cents a mile to run a two-horse car for every mile it runs, according to the president of the leading street railway company in Philadelphia, and he believes that the wire-rope will do the work at four cents a mile.

The St. Paul, Minneapolis & Manitoba Railroad Company have completed their grade from Grand Forks to the British line. This extension completes the line running from Fargo north. This new road runs northwest and north from Grand Forks and parallel with the Red River, keeping about twelve miles west of the river. A large crew of men are laying iron, and about fifty miles will be laid within the next sixty days to Grafton, in the center of Walsh County.

The Burnett, Wis., *County Sentinel* says: "We understand that there is a surveying party between Pine City and the St. Croix River running out a line, an extension of the line run out from St. Cloud to Pine City. This is a party sent out by the St. Paul and Manitoba road, who wish to put a road through to the Sault Ste. Marie. It is also reported that contracts have been let for grading part of the distance between St. Cloud and Pine City.

The proposed extension of the Camden, Gloucester and Mount Ephraim Railroad to Blackwoodtown has been surveyed to Chew's Landing. It is intended to have the surveys completed so that work on the road-bed may be begun by the 1st proximo, when it is thought that the $60,000 of subscriptions for building it will have been made, as it now lacks only about $10,000 of the amount. The continuation of the road to some point beyond Blackwoodtown is considered probable.

W. J. Craig, President of the Western Construction Company, which is building the Toledo, Cincinnati & St. Louis narrow-gauge line from Toledo to St. Louis, said to a St. Louis reporter last week: "We are working all along the line and hope to have it finished by Nov. 1. We are working through Madison County. H. S. Hopkins' Company, of St. Louis, are engaged on the timber work, trestles and Howe truss bridges. Between St. Louis and Kokomo, Ind., there are over 8,000,000 feet of trestle and bridging to be made. They will finish the piers across the Wabash River, near Eugene, Ind., this week. We have commenced shipping 4,000 tons of steel to Ramsey from St. Louis. We have six barge-loads of iron here now from England. We will use on this extension 25,000 tons of iron between here and Kokomo, a distance of about 244 miles. In a general way, it may be stated that the line is covered with men, and by September 1 there will be track-laying in four different places going on at the same time, putting down at the rate of five miles a day. We will commence track-laying next week at Ridge Farm and Oakland. We are laying track now at Naga, Ill., at the crossing of the Illinois Central, and have seven miles of iron laid there now."

The New York *Graphic* says: The extent of the railroad-building mania, which is now raging throughout the country, may be estimated by the following facts: A well-known and extensive commission house of this city, engaged exclusively in supplying railroad stores and machinery, the other day sold 20 locomotives for a new road, the locomotives still to be built. The price to be paid was large, but had it been possible for the locomotives to have been delivered at once, they could have been sold for a much larger price. The same house received the other day an order for a considerable number of sets of surveyors' instruments, to be supplied immediately, but they could not be found at any of the instrument-makers, whose stocks were all exhausted, and a search throughout the city for second-hand instruments also proved fruitless. An order was received here, also, a few days since for two competent surveying engineers, to go to work immediately upon a new line, with very liberal pay and expenses defrayed, but they could not be found in the city. Everything in the railroad line is "booming," and a harvest is being reaped by manufacturers, commission merchants, engineers and surveyors, such as they have not had for many a long year.

RIVERS AND HARBORS.

St. Louis, Mo., Aug. 19.—The Executive Committee, appointed yesterday by the President of the Merchants' Exchange, to arrange for holding a River Improvement Convention in this city on Oct. 26, met to-day, and organized by electing Michael McEnnis, President of the Merchants' Exchange, Chairman, and Frank Galennie and George L. Wright, Secretaries. A call was adopted setting forth the objects of the Convention, and asking the Governors of all the States and Territories, all Mayors of cities, and all Boards in the Mississippi Valley, to send representative men as delegates to the Convention. All Governors of States and Territories in the Valley, and all members of both Houses of Congress, will receive special invitations to be present. The call, which will explain the basis of the representation, will be sent to all trade centers in the Valley. The Executive Committee will appoint sub-committees to represent the different commercial interests of the city, and every effort will be made to make the Convention thoroughly representative in character.

The report of Mr. Thomas P. Roberts, engineer in charge of the Alleghany River improvement, has been presented to General Wright, Chief of Engineers at Washington. Mr. Roberts renews his recommendation made in 1880, that a lock and dam be built below Garrison Ripple for the improvement of Alleghany Harbor of Pittsburgh, and as the only practical means of getting rid of a shoal which is now the greatest obstacle to the navigation of the river. It is proposed to expend the $25,000 appropriated March 3, 1881, in removing obstructions and in making special surveys of the more troublesome points, with a view of their ultimate improvement. The very large transfer business done in the harbor of Pittsburgh would be greatly increased if the limitations now imposed on it by low water were removed by the construction of a dam at or near the foot of Herr's Island. The engineer says the amount needed for the improvement of open navigation on a river like the Alleghany cannot be definitely stated without detailed surveys, which are thus far lacking. Any reasonable sum can be advantageously expended in closing duplicate channels, and in removing the rocks which everywhere abound in the bed and on the shores. He therefore submits an estimate of $50,000 for improving the general navigation during the year ending June 30, 1883. He reports that on July 1 there was $25,149 available for the current fiscal year.

CANALS.

The Sturgeon Bay canal will be completed according to contract by Oct. 15, when an average depth of 12 feet will be reached. At present the contractor for the work is driving piles along the sides for the purpose of protecting the banks. The depth of the water is now 12 feet, and all vessels trading to Green Bay ports have no difficulty in passing through loaded.

Baltimore, Aug. 5.—The early construction of the ship canal connecting Chesapeake Bay with Delaware Bay, shortening the distance to the ocean from this port by 225 miles, is now assured. The Sassafras route has been selected, requiring only a cut of eight miles to connect the Sassafras River with the Blackbird Creek. The estimated cost is $8,000,000. It is stated that the canal will be opened in two years. The Canal Company will issue $4,000,000 worth of bonds, all of which have been subscribed for in Paris, and $4,000,000 of stock, of which $2,000,000 have been taken in Paris, and $2,000,000 are held by New York capitalists. The contract for the work will be let immediately. The charter of the company fixes the maximum charge at 20 cents per ton for vessels. The canal will be 120 feet wide, with a uniform depth of 26 feet. A dispatch of the 18th relative to the same subject says: "Mr. S. Fulda, of Berlin, Germany, was in this city yesterday as the representative of the two Paris firms who have agreed to invest capital for the construction of the Sassafras route of the Maryland & Delaware Ship Canal, if they can receive assurances that it will be a paying investment. Mr. Fulda stated that he had been assured that the construction of the canal by the Sassafras route would cost only $4,000,000. If the French capitalists decide to make the investment, they intend to make the tolls as low as possible, and do not expect to realize any profits for the first two or three years. It is their opinion that with low tolls the canal would develop the commerce of Baltimore to such an extent that in time the waterway would prove a paying investment."

NEW PROJECTS.

It is reported that a union depot is to be built at Salamanca for the joint use of the New York, Pennsylvania & Ohio Railroad, the Erie Railway and the Buffalo, Pittsburgh & Western Railroad.

The Chicago, Milwaukee & St. Paul Company intend to make a connection with the Chicago, Burlington & Quincy road, to run freight into St. Louis from Wisconsin. The former will spread out its branches in Wisconsin and elsewhere, fan shape, so as to contribute to this new line, which will be west of the Missouri, and probably be over a portion of the Burlington, Cedar Rapids & Northern, which is controlled by the Chicago, Burlington & Quincy. The new line will be ready for business next spring.

The following incorporations were filed with the Secretary of State of Ohio, on the 18th: The Motherwell Iron & Steel Company, of Logan; capital, $50,000. The Pomeroy & Ohio River Railroad Company; capital, $500,000. The proposed line of railway to extend from Pomeroy to the point on the Ohio & West Virginia State line where the Point Pleasant & Ohio River Railroad intersects. It will be an extension of the Ohio Central. The incorporators are George I. Seeney, Samuel Thomas, Allan A. Dennison, Calvin S. Brice, Samuel Shelthar and Charles N. Lamison.

The articles of association of the Buffalo, Rochester & Pittsburgh Railroad Company were filed with the Secretary of State Aug. 18. The company is to continue in existence for ninety-nine years, and the capital stock is $500,000. The road is to be constructed from a point at or within the limits of the town of Machias, Cattaraugus county, at a place most favorable for connection with the Rochester & Pittsburgh Railroad, running by the most direct and feasible route through the counties of Cattaraugus and Erie, in this State, to Buffalo, and terminating at a point within or near the city limits. The length of the road will be about 50 miles. Walson H. Brown, Frederick A. Brown, Frank G. Wentworth, Herbert P. Brown, Thomas F. Wentworth, Wm. M. Shaffner, Lennox Smith, Aaron H. Cragin, Henry R. Southworth, New York City; Nelson Robinson, Russell F. Webb, Brooklyn; Thomas B. Browning, Staten Island, and Fred. J. Stone, Dobbs Ferry, are directors.

CONTRACTING, MISCELLANEOUS, ETC.

The new library building of Columbia College, New York, will cost $250,000.

The London *Iron Trade Exchange*, of recent date, publishes a complete list of blast furnaces in and out of blast in the United Kingdom. From the returns it appears that out of the total 943 furnaces built, 563 are in blast and 380 are standing idle. There are probably 40 furnaces in various districts which are not included in the returns, but none of these have been in blast for many years, and they will never be relighted; others are dismantled, and some have never been completed.

A company of Memphis (Tenn.) capitalists have just purchased over 50,000 acres of coal and timber lands near Birmingham, Ala., and organized the Birmingham Coal, Coke and Iron Company, with a capital stock of $2,000,000. It is the design of the company to erect at once several large iron furnaces, as well as to mine coal upon a very large scale and establish the largest coke works in the South. It is claimed that iron can be made at Birmingham for the cost of the ore delivered at the furnaces in Pennsylvania.